Problem Set 2

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CAP 4763 Time Series Modelling and Forecasting

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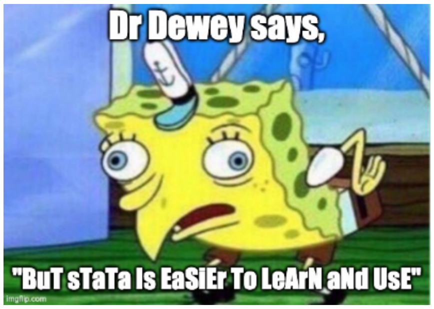


> I joke but I really shouldn't. I'm spending so much time worrying about how to do things in STATA and trying to understand how it works and make it do what I want that I have no clue what's going on in this class. I have become so frustrated with STATA to the point of crying at least once for each Problem Set and several times in between.
> I have no doubt that no matter how hard I try, I will fail the midterm.

Part A

1. Writethemodel $y_t = \alpha + \delta t + \rho y_{t-1} + \beta x_{t-1} + r$ in first differences.

- $\Delta y_t = \delta + \rho \Delta y_{t-1} + \beta \Delta x_{t-1} + \Delta r_t$

2. Suppose after first differencing a model is $\Delta y_t = \delta - \varphi - 2\varphi t + \rho \, \Delta \, y_{t-1} + \beta \, \Delta \, x_{t-1} + \Delta r_t$. What was it before the first difference was taken? (Hint: both t and t^2 are in it.)

- $y_t = \delta t + \varphi t^2 + \varphi t - \varphi + \rho y_{t-1} + \beta x_{t-1} + r_t$

3. Suppose you are originally interested in the model $y_t = \alpha + \delta t + \rho y_{t-1} + \beta x_{t-1} + r_t$, where $r_t = \gamma r_{t-1} + \varepsilon_t$ and ε_t is an independent random disturbance. Write the dynamically complete model in first differences. Hint: first substitute to make the model dynamically complete, and then take the first difference.

- $y_t = \alpha + \delta t + \rho y_{t-1} + \beta x_{t-1} + \gamma r_{t-1} + \varepsilon_t$
- $\Delta y_t = \delta + \rho \Delta y_{t-1} + \beta \Delta x_{t-1} + \gamma \Delta r_{t-1} + \Delta \varepsilon_t$

Part B

3. Autocorrelation and Weak Dependence

1. Obtain the correlation of each variable with its one period lag.

(obs=875)	**corr ln_us_epr l1.ln_us_epr**
	L.
	ln_us~*r ln_us*~r
ln_us_epr	
-.	1.0000
L1.	0.9758 1.0000

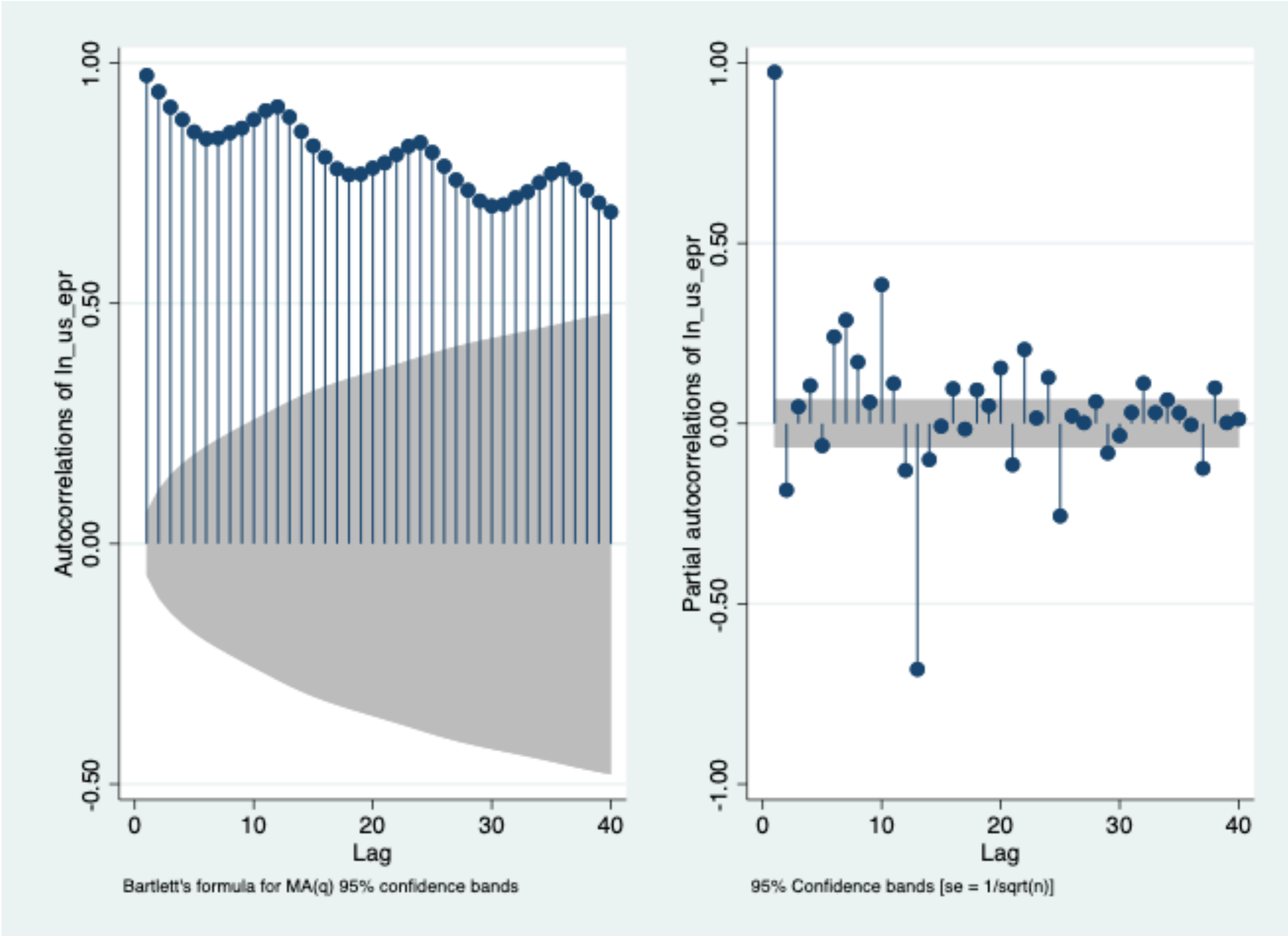
(obs=983)	**corr ln_fl_nonfarm l1.ln_fl_nonfarm**
	L.
	ln_fl~*m ln_fl*~m
ln_fl_nonf~m	
-.	1.0000
L1.	0.9999 1.0000

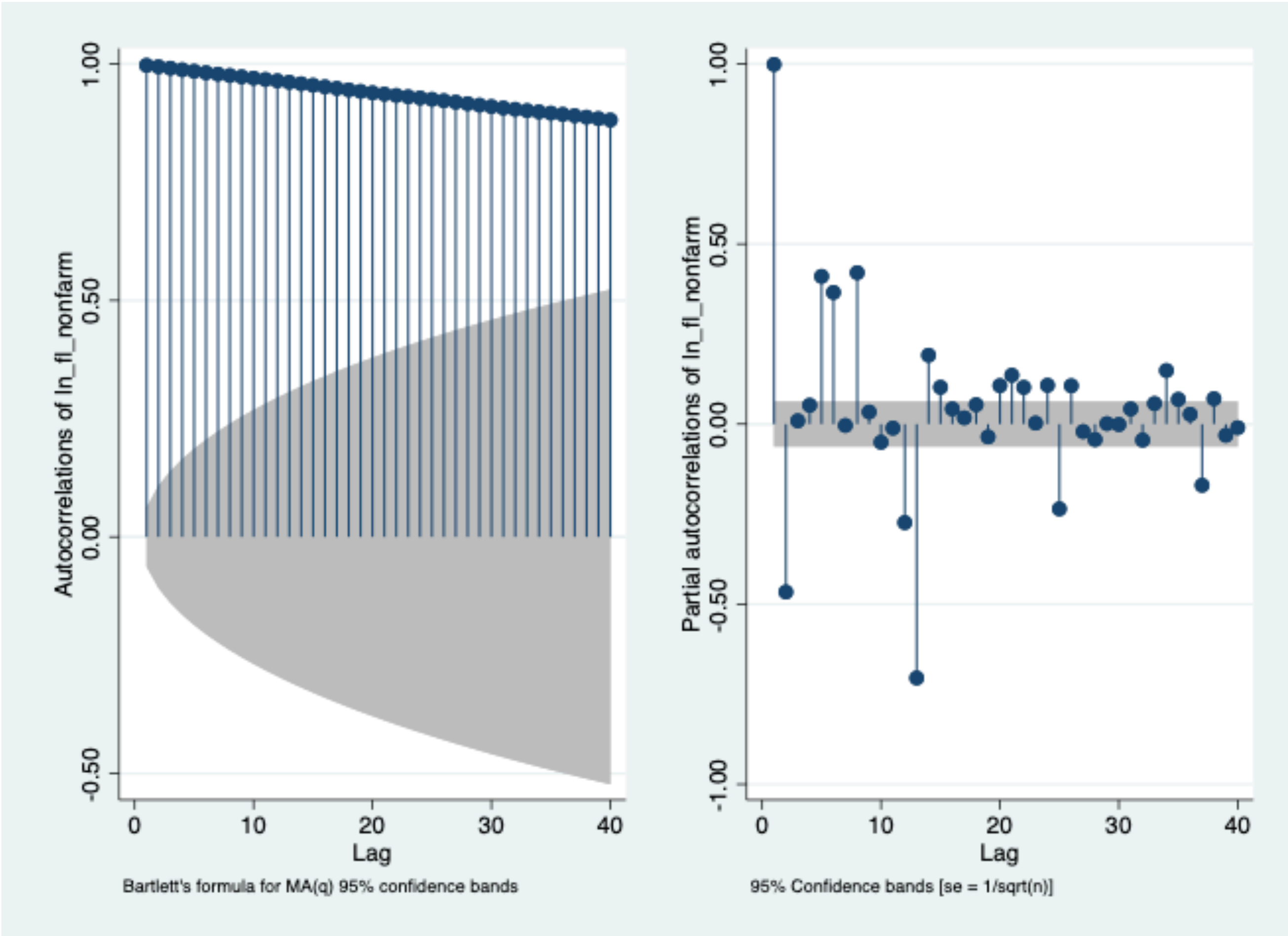
(obs=539)	corr ln_fl_lf l1.ln_fl_lf
	L.
	ln_fl_lf ln_fl_lf
ln_fl_lf	
-.	1.0000
L1.	0.9997 1.0000

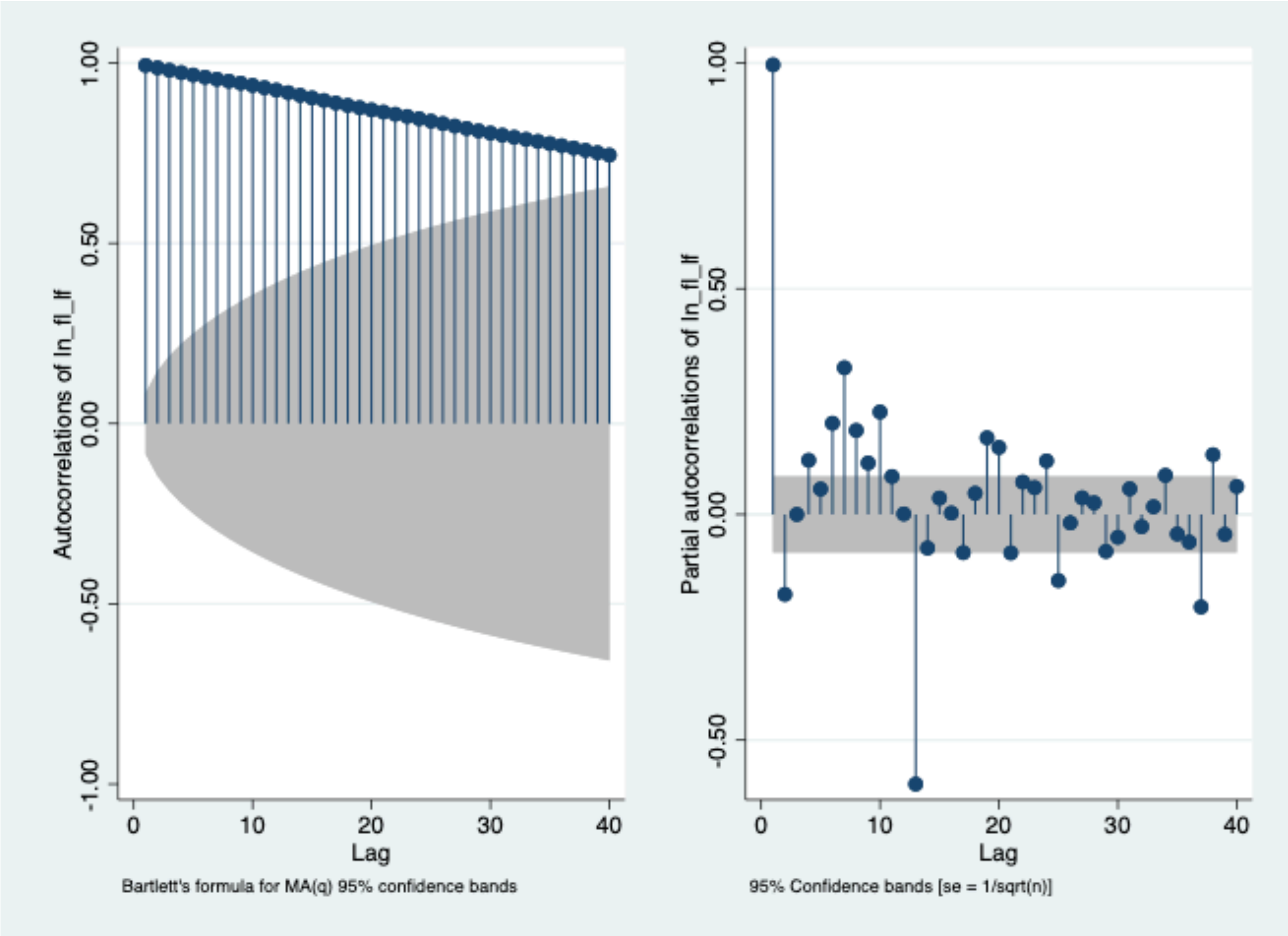
(obs=395)	corr ln_fl_bp l1.ln_fl_bp
	L.
	ln_fl_bp ln_fl_bp
ln_fl_bp	
-.	1.0000
L1.	0.9470 1.0000

- There appears to be very high correlation between the log form of each variable and its first lag. The highest is ln_fl_nonfarm with a correlation of .9999, followed by ln_fl_lf, ln_us_epr, and ln_fl_bp with .9997, .9758, and .9470 respectively.

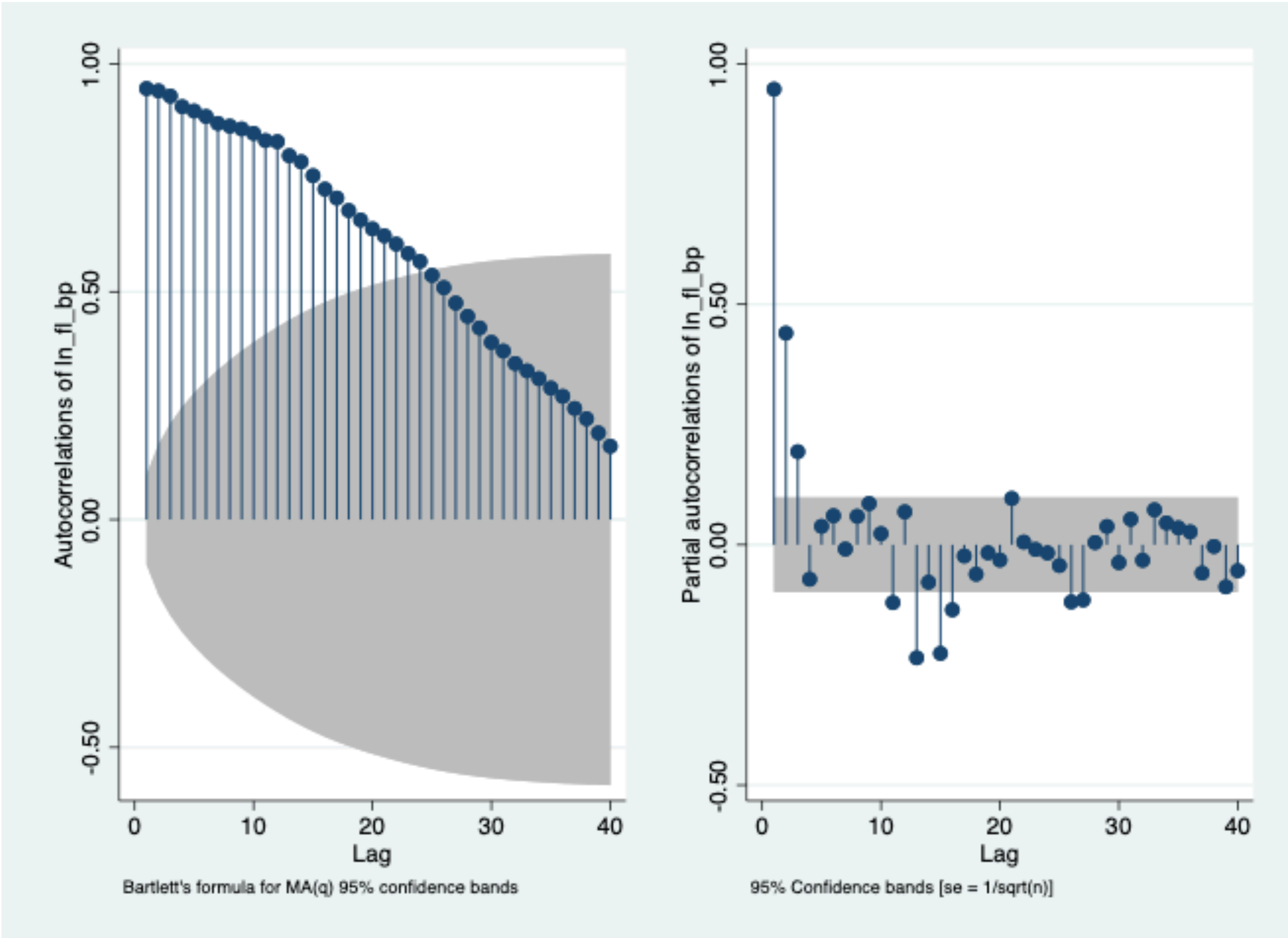
2. Obtain the autocorrelogram and partial autocorrelagram for each variable.


Autocorrelations of ln_us_epr
1.00
0.50
0.00
-0.50
0
10
20
30
40
Lag
Bartlett's formula for MA(q) 95% confidence bands
Partial autocorrelations of ln_us_epr
1.00
0.50
0.00
-0.50
-1.00
0
10
20
30
40
Lag
95% Confidence bands [se = 1/sqrt(n)]


Autocorrelations of ln_fl_nonfarm
Lag
Bartlett's formula for MA(q) 95% confidence bands
Partial autocorrelations of ln_fl_nonfarm
Lag
95% Confidence bands [se = 1/sqrt(n)]



For the above three graphs, because all of the points are outside and above the cone, we can conclude that there is an autoregressive term in the data and should consult the partial autocorrelation graph. The PAC suggests that this is a higher order moving average.



For the last graph, the autocorrelation is not all outside of the confidence interval. When we look at the PAC we see that there are significant correlations in the first few terms followed by insignificant correlations in the rest. This suggests the order of the autoregressive term.

3. Conduct the Dickey-Fuller unit root rest for each variable.

> I promise I really wanted to do nice tables here but for the life of me couldn't get stata to let me copy them properly or export them and I really didn't want to transcribe them

```
. dfuller ln_us_epr, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       875

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.020            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0082

------------------------------------------------------------------------------
 D.ln_us_epr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ln_us_epr |
         L1. |  -.0392314   .0097585    -4.02   0.000    -.0583843   -.0200784
             |
      _trend |   4.02e-06   1.84e-06     2.18   0.030     3.99e-07    7.63e-06
       _cons |   .1583652   .0392952     4.03   0.000     .0812411    .2354894
------------------------------------------------------------------------------
```

```
. dfuller ln_fl_nonfarm, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       983

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.653            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9761

------------------------------------------------------------------------------
D.           |
ln_fl_nonfarm|      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ln_fl_nonfarm|
          L1.|   -.001659   .0025399    -0.65   0.514    -.0066433    .0033253
             |
       _trend|   6.93e-07   8.56e-06     0.08   0.935    -.0000161    .0000175
        _cons|   .0159216   .0160282     0.99   0.321    -.0155318    .0473751
------------------------------------------------------------------------------

. dfuller ln_fl_lf, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       539

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.724            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7400

------------------------------------------------------------------------------
  D.ln_fl_lf |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_lf |
         L1. |  -.0076457   .0044337    -1.72   0.085    -.0163552    .0010639
             |
      _trend |   7.40e-06   8.61e-06     0.86   0.391    -9.52e-06    .0000243
       _cons |    .120517   .0676628     1.78   0.075    -.0123997    .2534337
------------------------------------------------------------------------------

. dfuller ln_fl_bp, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       395

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.256            -3.984            -3.424            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0738

------------------------------------------------------------------------------
  D.ln_fl_bp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_bp |
         L1. |  -.0545463   .0167509    -3.26   0.001    -.0874792   -.0216134
             |
      _trend |  -.0000375   .0000734    -0.51   0.609    -.0001817    .0001067
       _cons |   .5091679   .1583766     3.21   0.001     .1977942    .8205417
------------------------------------------------------------------------------
```

For both Dickey-Fuller of the ln_us_epr, the p-value is extremely low at .0082 and so we accept the null hypothesis. For all others, we fail to reject the null hypothesis. Especially ln_fl_nonfarm and ln_fl_lf.

4. ARDL Model and Breusch-Godfrey Test

Given the results of the previous question, transform the data as needed and estimate a dynamically complete ARDL model for non-farm employment. Include at least one lag of the relevant dependent variable. How many additional lags of the dependent variable, and how many lags of which independent variables you include, are up to you. Looking back at what you did for Problem Set 1 might be informative, but don't be limited by it. Produce and interpret the AC and PAC for the residuals and the results of a Breusch-Godfrey test.

In your write up, justify your specification and interpret the results.

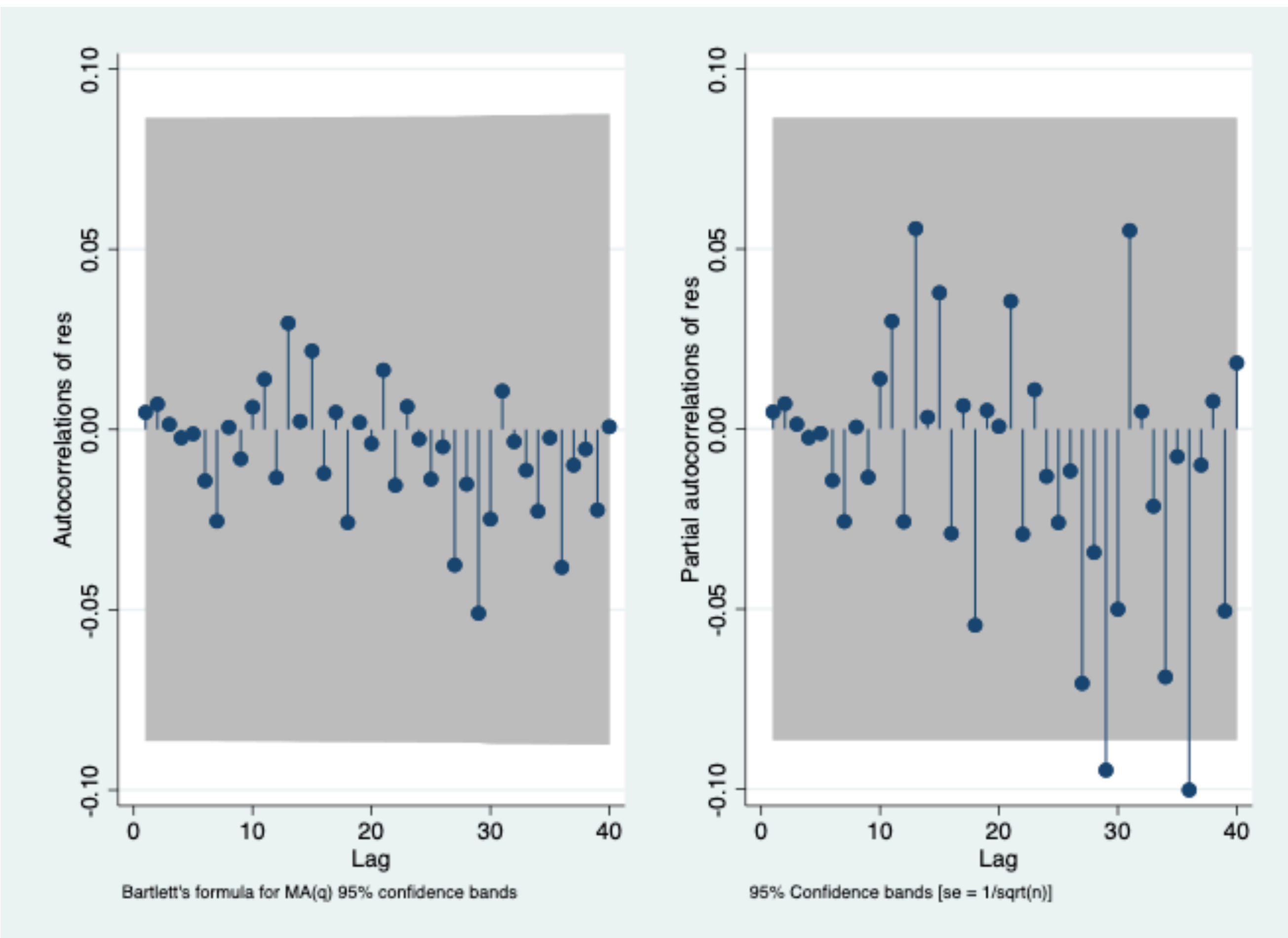
> I really wanted to try doing every other lag rather than every lag as Jake suggested but I couldn't find a way to generate a sequence of every other number in a set range. I tried doing
>
> ```
> gen seq3 = 2*mod(_n-1,48)
> ```
>
> but couldn't check if it was right because the data viewer isn't showing anything then when I tried to use it I got an error that it wasn't a valid list of numbers.

.	**regress d.ln_fl_nonfarm l(1/48)d.ln_fl_nonfarm**	**l(12/24)d.ln_us_epr**	**l(1/18, 24)d.ln_fl_lf**	**date**
	Source SS df MS	Number of obs =	515	
	F(81, 433) =	15.48		
Model .050091055 81 .000618408	Prob > F =	0.0000		
Residual .01729335 433 .000039938	R-squared =	0.7434		
	Adj R-squared =	0.6954		
Total .067384405 514 .000131098	Root MSE =	.00632		
-------------	---------	---------	-----	-----
D.				
ln_fl_nonfarm	Coef.	Std. Err.	t	P>t
ln_fl_nonfarm				
LD.	-.1441103	.059346	-2.43	0.016
L2D.	-.1332106	.060728	-2.19	0.029
L3D.	.0520745	.060831	0.86	0.392
L4D.	.1139409	.0609067	1.87	0.062
L5D.	.066288	.0611891	1.08	0.279
L6D.	.1944856	.0614959	3.16	0.002
L7D.	.0759452	.0622902	1.22	0.223
L8D.	.0829208	.0631492	1.31	0.190
L9D.	.2532911	.0930772	2.72	0.007
L10D.	.1403499	.0960901	1.46	0.145
L11D.	.1893271	.0946093	2.00	0.046

L12D.	.4685154	.0957577	4.89	0.000
L13D.	.0758492	.1003991	0.76	0.450
L14D.	.0089228	.1008964	0.09	0.930
L15D.	.0490602	.1006788	0.49	0.626
L16D.	-.0187785	.1013922	-0.19	0.853
L17D.	.0547956	.1017669	0.54	0.591
L18D.	.0863921	.1011552	0.85	0.394
L19D.	-.25835	.1016689	-2.54	0.011
L20D.	-.1621826	.1009034	-1.61	0.109
L21D.	-.0839614	.1033319	-0.81	0.417
L22D.	-.1719582	.1017154	-1.69	0.092
L23D.	.0347504	.1011416	0.34	0.731
L24D.	.2927769	.0998811	2.93	0.004
L25D.	.1178616	.098203	1.20	0.231
L26D.	.0999885	.0980021	1.02	0.308
L27D.	-.1283723	.0980801	-1.31	0.191
L28D.	-.2031139	.0980964	-2.07	0.039
L29D.	-.2892074	.097907	-2.95	0.003
L30D.	-.5772115	.0991658	-5.82	0.000
L31D.	.6236058	.1020615	6.11	0.000
L32D.	.1870999	.1073141	1.74	0.082
L33D.	.1426809	.1091241	1.31	0.192
L34D.	.1068341	.1078243	0.99	0.322
L35D.	-.0794067	.1078368	-0.74	0.462
L36D.	.1327386	.1064489	1.25	0.213
L37D.	-.0639028	.099194	-0.64	0.520
L38D.	-.048562	.0984536	-0.49	0.622
L39D.	.0871388	.0975069	0.89	0.372
L40D.	-.1442082	.0974565	-1.48	0.140
L41D.	-.0032331	.0966638	-0.03	0.973
L42D.	.0938246	.0970599	0.97	0.334
L43D.	-.3559573	.0966539	-3.68	0.000

L44D.	-.0089124	.0978207	-0.09	0.927
L45D.	-.0882528	.0966085	-0.91	0.361
L46D.	.1086727	.091884	1.18	0.238
L47D.	.0313382	.091654	0.34	0.733
L48D.	.0609195	.091323	0.67	0.505
ln_us_epr				
L12D.	-.0155085	.1744885	-0.09	0.929
L13D.	-.3056076	.153451	-1.99	0.047
L14D.	-.5608006	.1545155	-3.63	0.000
L15D.	-.3645519	.1519838	-2.40	0.017
L16D.	.0029936	.1580302	0.02	0.985
L17D.	.0422232	.1559561	0.27	0.787
L18D.	.3199335	.1565006	2.04	0.042
L19D.	-.07463	.0988972	-0.75	0.451
L20D.	.0625226	.0999685	0.63	0.532
L21D.	-.0436852	.1002131	-0.44	0.663
L22D.	.2231831	.0985078	2.27	0.024
L23D.	-.0081188	.0960409	-0.08	0.933
L24D.	-.2688582	.1616447	-1.66	0.097
ln_fl_lf				
LD.	.1762398	.0704433	2.50	0.013
L2D.	-.1356975	.0715783	-1.90	0.059
L3D.	-.1659446	.0715828	-2.32	0.021
L4D.	-.0977864	.0709175	-1.38	0.169
L5D.	-.1364495	.0722069	-1.89	0.059
L6D.	-.2270642	.0723796	-3.14	0.002
L7D.	-.1332104	.0724525	-1.84	0.067
L8D.	-.2396185	.0727056	-3.30	0.001
L9D.	-.1256755	.079465	-1.58	0.114
L10D.	-.180737	.0797732	-2.27	0.024

L11D.	-.005726	.0808095	-0.07	0.944
L12D.	.0558537	.1334055	0.42	0.676
L13D.	.0173463	.1262683	0.14	0.891
L14D.	.2969825	.1275491	2.33	0.020
L15D.	.125207	.1266497	0.99	0.323
L16D.	-.0665773	.1288379	-0.52	0.606
L17D.	-.1292395	.1273895	-1.01	0.311
L18D.	-.2883037	.1278108	-2.26	0.025
L24D.	.2278015	.1255369	1.81	0.070
date	-8.65e-06	3.19e-06	-2.72	0.007
_cons	.0058495	.0022338	2.62	0.009

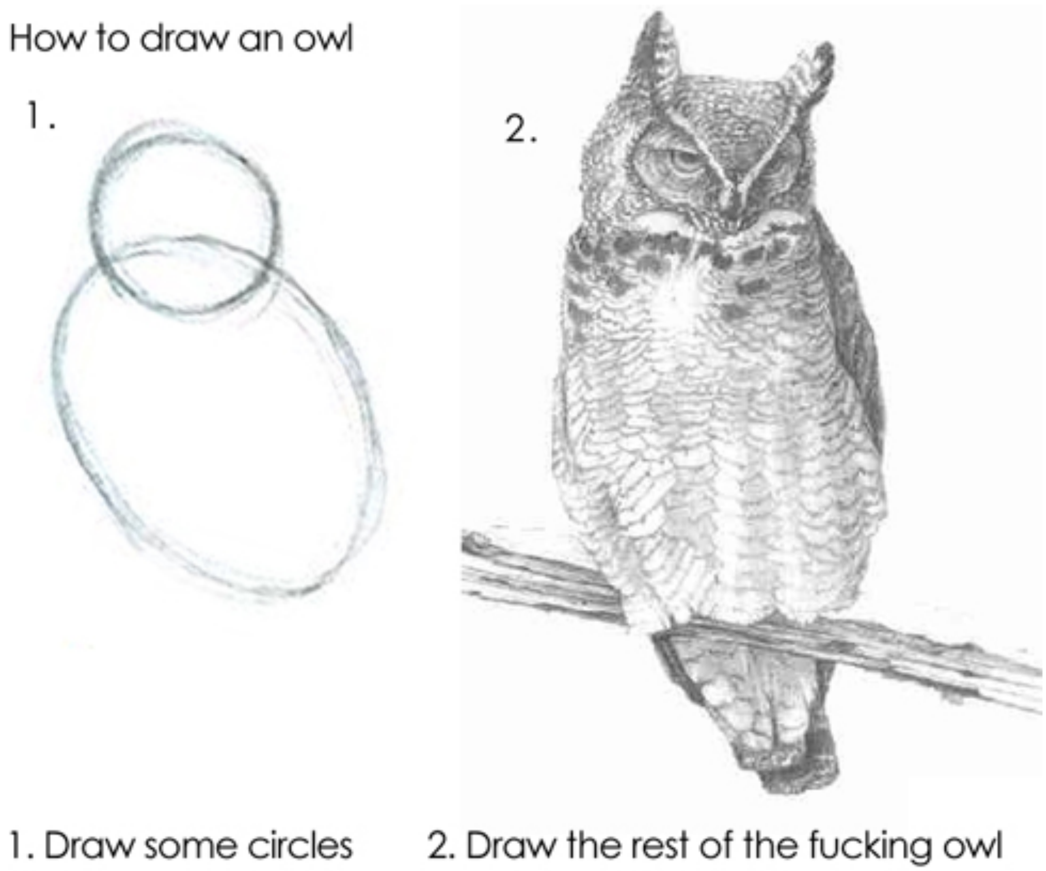


I don't think there's any correlation because almost everything is inside the interval.

. estat bgodfrey, lag(1/48)	
Breusch-Godfrey LM test for	autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.617	1	0.4321
2	1.630	2	0.4427
3	1.639	3	0.6506
4	1.665	4	0.7970
5	1.730	5	0.8850
6	2.757	6	0.8387
7	8.252	7	0.3109
8	8.536	8	0.3830
9	8.707	9	0.4648
10	8.803	10	0.5509
11	9.015	11	0.6205
12	10.913	12	0.5364
13	12.697	13	0.4715
14	12.775	14	0.5443
15	14.075	15	0.5198
16	15.212	16	0.5091
17	15.284	17	0.5751
18	18.315	18	0.4351
19	18.317	19	0.5014
20	19.893	20	0.4647
21	19.920	21	0.5263
22	20.203	22	0.5704

23	20.218	23	0.6287
24	20.362	24	0.6760
25	21.112	25	0.6864
26	21.381	26	0.7221
27	23.290	27	0.6693
28	24.359	28	0.6624
29	25.322	29	0.6615
30	27.716	30	0.5855
31	28.706	31	0.5846
32	28.728	32	0.6330
33	29.272	33	0.6533
34	30.894	34	0.6207
35	30.897	35	0.6666
36	33.834	36	0.5720
37	35.071	37	0.5597
38	35.519	38	0.5847
39	38.229	39	0.5049
40	38.448	40	0.5402
41	38.548	41	0.5801
42	39.001	42	0.6034
43	39.107	43	0.6408
44	39.122	44	0.6804
45	39.431	45	0.7061
46	39.812	46	0.7278
47	40.011	47	0.7550
48	40.617	48	0.7664
H0: no serial correlation			

> I'm so confused. It is at this point that I'm giving up trying to interpret stuff. I've spent nearly all day on it and am just as lost as before. I understand the basic commands such as regress and gen and all that. I know how to use the other commands. I don't understand what the functions are doing or why the results mean what they are said to mean. I feel like I'm being asked to draw an owl and these are my only instructions:
>
> 
>
>
> I know you've said time and time again that I don't need to know what stata's doing in the background but I don't understand the math and I can't see what stata's doing for the math. In lecture all I see is a bunch of letters set up for an equation that doesn't mean anything to me outside of super abstract concepts.
> Hailey and Jake and Mohammad will do their best to help me through everything. I'm reasonably certain that I can pass with about a 2 or so if my grade calculator is correct and my estimates are too. I'm not sure if it's worth it to stay in and just accept the hit to my GPA or not. Anyways. I'm going to turn this in now. I hope you're not too disappointed.

5. Dynamically Complete Models and Newey-West Standard Errors

```
. reg d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1)

      Source |       SS           df       MS      Number of obs   =       380
-------------+----------------------------------   F(5, 374)       =      2.97
       Model |  .00146591         5  .000293182   Prob > F        =    0.0122
    Residual |  .036972226       374  .000098856   R-squared       =    0.0381
-------------+----------------------------------   Adj R-squared   =    0.0253
       Total |  .038438136       379   .00010142   Root MSE        =    .00994

------------------------------------------------------------------------------
D.           |
ln_fl_nonf~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_bp |
         D1. |  -.0043445   .0035864    -1.21   0.227    -.0113965    .0027075
         LD. |  -.0115113   .0040594    -2.84   0.005    -.0194935   -.0035291
        L2D. |   .0019871   .0041056     0.48   0.629    -.0060858      .01006
        L3D. |  -.0011778   .0040768    -0.29   0.773    -.0091941    .0068385
        L4D. |  -.0028262   .0036121    -0.78   0.434    -.0099287    .0042763
             |
       _cons |   .0015358   .0005101     3.01   0.003     .0005328    .0025387
------------------------------------------------------------------------------

. newey d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1), lag(4)

Regression with Newey-West standard errors      Number of obs     =        380
maximum lag: 4                                  F(  5,        374) =       4.01
                                                Prob > F          =     0.0015

------------------------------------------------------------------------------
D.           |             Newey-West
ln_fl_nonf~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_bp |
         D1. |  -.0043445    .003622    -1.20   0.231    -.0114665    .0027776
         LD. |  -.0115113   .0036606    -3.14   0.002    -.0187093   -.0043133
        L2D. |   .0019871   .0043475     0.46   0.648    -.0065616    .0105358
        L3D. |  -.0011778    .004813    -0.24   0.807    -.0106416     .008286
        L4D. |  -.0028262    .003664    -0.77   0.441    -.0100308    .0043783
             |
       _cons |   .0015358   .0004154     3.70   0.000     .0007189    .0023526
------------------------------------------------------------------------------
```

if fuller high, can't reject

Appendix A

```
clear
set more off

cd "/Users/guslipkin/Documents/Spring2020/CAP 4763 ~ Time Series/Problem Sets/Problem Set 2"

*2a
*Done

*2b Load the data
import delimited "Assignment_1_Monthly.txt"

```

```
rename lnu02300000 us_epr
rename flnan fl_nonfarm
rename fllfn fl_lf
rename flbppriv fl_bp
rename date datestring

*2c Turn on a log file
log using "Problem Set 1", replace

*2d Generate a monthly date variable (make its display format monthly time, %tm)
gen datec=date(datestring, "YMD")
gen date=mofd(datec)
format date %tm

*2e tsset your data
tsset date

*2f
gen ln_us_epr=log(us_epr)
gen ln_fl_nonfarm=log(fl_nonfarm)
gen ln_fl_lf=log(fl_lf)
gen ln_fl_bp=log(fl_bp)

*3a
corr ln_us_epr l1.ln_us_epr
corr ln_fl_nonfarm l1.ln_fl_nonfarm
corr ln_fl_lf l1.ln_fl_lf
corr ln_fl_bp l1.ln_fl_bp

*3b
ac ln_us_epr, saving(ac_ln_us_epr.gph, replace)
pac ln_us_epr, saving(pac_ln_us_epr.gph, replace)
graph combine ac_ln_us_epr.gph pac_ln_us_epr.gph, saving(combo_ln_us_epr.gph, replace)

ac ln_fl_nonfarm, saving(ac_ln_fl_nonfarm.gph, replace)
pac ln_fl_nonfarm, saving(pac_ln_fl_nonfarm.gph, replace)
graph combine ac_ln_fl_nonfarm.gph pac_ln_fl_nonfarm.gph, saving(combo_ln_fl_nonfarm.gph, replace)

ac ln_fl_lf, saving(ac_ln_fl_lf.gph, replace)
pac ln_fl_lf, saving(pac_ln_fl_lf.gph, replace)
graph combine ac_ln_fl_lf.gph pac_ln_fl_lf.gph, saving(combo_ln_fl_lf.gph, replace)

ac ln_fl_bp, saving(ac_ln_fl_bp.gph, replace)
pac ln_fl_bp, saving(pac_ln_fl_bp.gph, replace)
graph combine ac_ln_fl_bp.gph pac_ln_fl_bp.gph, saving(combo_ln_fl_bp.gph, replace)

*3c
dfuller ln_us_epr, trend regress
dfuller ln_fl_nonfarm, trend regress
```

```
dfuller ln_fl_lf, trend regress
dfuller ln_fl_bp, trend regress

*4
regress d.ln_fl_nonfarm l(1/48)d.ln_fl_nonfarm l(12/24)d.ln_us_epr l(1/18,
24)d.ln_fl_lf date
predict res, residual
ac res, saving(p4_ac.gph, replace)
pac res, saving(p4_pac.gph, replace)
graph combine p4_ac.gph p4_pac.gph, saving(p4_combo.gph, replace)
estat bgodfrey, lag(1/48)

*5
reg d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1)
newey d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1), lag(4)

log close
```

Appendix B

```
      name:  <unnamed>
       log:  /Users/guslipkin/Documents/Spring2020/CAP 4763 ~ Time Series/Problem S
> ets/Problem Set 2/Problem Set 1.smcl
  log type:  smcl
 opened on:  26 Feb 2021, 18:08:56

.
. *2d Generate a monthly date variable (make its display format monthly time, %tm)
. gen datec=date(datestring, "YMD")

. gen date=mofd(datec)

. format date %tm

.
. *2e tsset your data
. tsset date
        time variable:  date, 1939m1 to 2020m12
                delta:  1 month

.
. *2f
. gen ln_us_epr=log(us_epr)
(108 missing values generated)

. gen ln_fl_nonfarm=log(fl_nonfarm)

. gen ln_fl_lf=log(fl_lf)
(444 missing values generated)

. gen ln_fl_bp=log(fl_bp)
(588 missing values generated)

.
. *3a
. corr ln_us_epr l1.ln_us_epr
(obs=875)

             |                 L.
             | ln_us_~r ln_us_~r
-------------+------------------
   ln_us_epr |
         --. |   1.0000
         L1. |   0.9758   1.0000


. corr ln_fl_nonfarm l1.ln_fl_nonfarm
(obs=983)

             |                 L.
             | ln_fl_~m ln_fl_~m
-------------+------------------
ln_fl_nonf~m |
         --. |   1.0000
         L1. |   0.9999   1.0000
```

```
. corr ln_fl_lf l1.ln_fl_lf
(obs=539)

             |                L.
             | ln_fl_lf ln_fl_lf
-------------+------------------
    ln_fl_lf |
         --. |   1.0000
         L1. |   0.9997   1.0000


. corr ln_fl_bp l1.ln_fl_bp
(obs=395)

             |                L.
             | ln_fl_bp ln_fl_bp
-------------+------------------
    ln_fl_bp |
         --. |   1.0000
         L1. |   0.9470   1.0000


.
. *3b
. ac ln_us_epr, saving(ac_ln_us_epr.gph, replace)
(file ac_ln_us_epr.gph saved)

. pac ln_us_epr, saving(pac_ln_us_epr.gph, replace)
(file pac_ln_us_epr.gph saved)

. graph combine ac_ln_us_epr.gph pac_ln_us_epr.gph, saving(combo_ln_us_epr.gph, rep
> lace)
(file combo_ln_us_epr.gph saved)

.
. ac ln_fl_nonfarm, saving(ac_ln_fl_nonfarm.gph, replace)
(file ac_ln_fl_nonfarm.gph saved)

. pac ln_fl_nonfarm, saving(pac_ln_fl_nonfarm.gph, replace)
(file pac_ln_fl_nonfarm.gph saved)

. graph combine ac_ln_fl_nonfarm.gph pac_ln_fl_nonfarm.gph, saving(combo_ln_fl_nonf
> arm.gph, replace)
(file combo_ln_fl_nonfarm.gph saved)

.
. ac ln_fl_lf, saving(ac_ln_fl_lf.gph, replace)
(file ac_ln_fl_lf.gph saved)

. pac ln_fl_lf, saving(pac_ln_fl_lf.gph, replace)
(file pac_ln_fl_lf.gph saved)

. graph combine ac_ln_fl_lf.gph pac_ln_fl_lf.gph, saving(combo_ln_fl_lf.gph, replac
> e)
(file combo_ln_fl_lf.gph saved)

.
. ac ln_fl_bp, saving(ac_ln_fl_bp.gph, replace)
(file ac_ln_fl_bp.gph saved)

. pac ln_fl_bp, saving(pac_ln_fl_bp.gph, replace)
(file pac_ln_fl_bp.gph saved)

. graph combine ac_ln_fl_bp.gph pac_ln_fl_bp.gph, saving(combo_ln_fl_bp.gph, replac
> e)
(file combo_ln_fl_bp.gph saved)

.
. *3c
. dfuller ln_us_epr, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       875

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.020            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0082

------------------------------------------------------------------------------
D.ln_us_epr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ln_us_epr |
         L1. |  -.0392314   .0097585    -4.02   0.000    -.0583843   -.0200784
             |
      _trend |   4.02e-06   1.84e-06     2.18   0.030     3.99e-07    7.63e-06
       _cons |   .1583652   .0392952     4.03   0.000     .0812411    .2354894
------------------------------------------------------------------------------

. dfuller ln_fl_nonfarm, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       983
```

```
                         ———————————— Interpolated Dickey-Fuller ————————————
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.653            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9761

-------------------------------------------------------------------------------
D.             |
ln_fl_nonfarm  |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+---------------------------------------------------------------
ln_fl_nonfarm  |
           L1. |   -.001659   .0025399    -0.65   0.514    -.0066433    .0033253
               |
        _trend |   6.93e-07   8.56e-06     0.08   0.935    -.0000161    .0000175
         _cons |   .0159216   .0160282     0.99   0.321    -.0155318    .0473751
-------------------------------------------------------------------------------

. dfuller ln_fl_lf, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       539

                         ———————————— Interpolated Dickey-Fuller ————————————
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.724            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7400

------------------------------------------------------------------------------
  D.ln_fl_lf |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_lf |
         L1. |  -.0076457   .0044337    -1.72   0.085    -.0163552    .0010639
             |
      _trend |   7.40e-06   8.61e-06     0.86   0.391    -9.52e-06    .0000243
       _cons |    .120517   .0676628     1.78   0.075    -.0123997    .2534337
------------------------------------------------------------------------------

. dfuller ln_fl_bp, trend regress

Dickey-Fuller test for unit root                   Number of obs   =       395

                         ———————————— Interpolated Dickey-Fuller ————————————
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.256            -3.984            -3.424            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0738

------------------------------------------------------------------------------
  D.ln_fl_bp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_fl_bp |
         L1. |  -.0545463   .0167509    -3.26   0.001    -.0874792   -.0216134
             |
      _trend |  -.0000375   .0000734    -0.51   0.609    -.0001817    .0001067
       _cons |   .5091679   .1583766     3.21   0.001     .1977942    .8205417
------------------------------------------------------------------------------

.
. *4
. regress d.ln_fl_nonfarm l(1/48)d.ln_fl_nonfarm l(12/24)d.ln_us_epr l(1/18, 24)d.l
> n_fl_lf date

      Source |       SS           df       MS      Number of obs   =       515
-------------+----------------------------------   F(81, 433)      =     15.48
       Model |  .050091055        81  .000618408   Prob > F        =    0.0000
    Residual |   .01729335       433  .000039938   R-squared       =    0.7434
-------------+----------------------------------   Adj R-squared   =    0.6954
       Total |  .067384405       514  .000131098   Root MSE        =    .00632

-------------------------------------------------------------------------------
D.             |
ln_fl_nonfarm  |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+---------------------------------------------------------------
ln_fl_nonfarm  |
           LD. |  -.1441103    .059346    -2.43   0.016    -.2607523   -.0274683
          L2D. |  -.1332106    .060728    -2.19   0.029    -.2525689   -.0138524
          L3D. |   .0520745    .060831     0.86   0.392    -.0674863    .1716354
          L4D. |   .1139409   .0609067     1.87   0.062    -.0057687    .2336504
          L5D. |    .066288   .0611891     1.08   0.279    -.0539766    .1865526
          L6D. |   .1944856   .0614959     3.16   0.002      .073618    .3153532
          L7D. |   .0759452   .0622902     1.22   0.223    -.0464836    .1983741
          L8D. |   .0829208   .0631492     1.31   0.190    -.0411963     .207038
          L9D. |   .2532911   .0930772     2.72   0.007     .0703519    .4362303
         L10D. |   .1403499   .0960901     1.46   0.145    -.0485112     .329211
         L11D. |   .1893271   .0946093     2.00   0.046     .0033766    .3752776
         L12D. |   .4685154   .0957577     4.89   0.000     .2803077    .6567232
         L13D. |   .0758492   .1003991     0.76   0.450    -.1214811    .2731795
         L14D. |   .0089228   .1008964     0.09   0.930    -.1893847    .2072303
         L15D. |   .0490602   .1006788     0.49   0.626    -.1488197      .24694
```

```
        L16D.  |  -.0187785   .1013922    -0.19   0.853    -.2180605    .1805035
        L17D.  |   .0547956   .1017669     0.54   0.591    -.1452228    .2548141
        L18D.  |   .0863921   .1011552     0.85   0.394    -.1124241    .2852084
        L19D.  |    -.25835   .1016689    -2.54   0.011    -.4581759   -.0585241
        L20D.  |  -.1621826   .1009034    -1.61   0.109     -.360504    .0361389
        L21D.  |  -.0839614   .1033319    -0.81   0.417    -.2870559    .1191331
        L22D.  |  -.1719582   .1017154    -1.69   0.092    -.3718755    .0279592
        L23D.  |   .0347504   .1011416     0.34   0.731    -.1640391    .2335399
        L24D.  |   .2927769   .0998811     2.93   0.004     .0964647     .489089
        L25D.  |   .1178616    .098203     1.20   0.231    -.0751523    .3108754
        L26D.  |   .0999885   .0980021     1.02   0.308    -.0926304    .2926074
        L27D.  |  -.1283723   .0980801    -1.31   0.191    -.3211445       .0644
        L28D.  |  -.2031139   .0980964    -2.07   0.039    -.3959182   -.0103096
        L29D.  |  -.2892074    .097907    -2.95   0.003    -.4816395   -.0967753
        L30D.  |  -.5772115   .0991658    -5.82   0.000    -.7721176   -.3823054
        L31D.  |   .6236058   .1020615     6.11   0.000     .4230083    .8242034
        L32D.  |   .1870999   .1073141     1.74   0.082    -.0238215    .3980212
        L33D.  |   .1426809   .1091241     1.31   0.192    -.0717978    .3571596
        L34D.  |   .1068341   .1078243     0.99   0.322    -.1050899    .3187581
        L35D.  |  -.0794067   .1078368    -0.74   0.462    -.2913554    .1325421
        L36D.  |   .1327386   .1064489     1.25   0.213    -.0764823    .3419594
        L37D.  |  -.0639028    .099194    -0.64   0.520    -.2588645    .1310589
        L38D.  |   -.048562   .0984536    -0.49   0.622    -.2420684    .1449445
        L39D.  |   .0871388   .0975069     0.89   0.372     -.104507    .2787845
        L40D.  |  -.1442082   .0974565    -1.48   0.140    -.3357548    .0473384
        L41D.  |  -.0032331   .0966638    -0.03   0.973    -.1932218    .1867555
        L42D.  |   .0938246   .0970599     0.97   0.334    -.0969425    .2845917
        L43D.  |  -.3559573   .0966539    -3.68   0.000    -.5459264   -.1659882
        L44D.  |  -.0089124   .0978207    -0.09   0.927    -.2011749    .1833501
        L45D.  |  -.0882528   .0966085    -0.91   0.361    -.2781327    .1016272
        L46D.  |   .1086727    .091884     1.18   0.238    -.0719214    .2892668
        L47D.  |   .0313382    .091654     0.34   0.733    -.1488038    .2114803
        L48D.  |   .0609195    .091323     0.67   0.505     -.118572     .240411
               |
    ln_us_epr  |
        L12D.  |  -.0155085   .1744885    -0.09   0.929    -.3584584    .3274413
        L13D.  |  -.3056076    .153451    -1.99   0.047     -.607209   -.0040062
        L14D.  |  -.5608006   .1545155    -3.63   0.000    -.8644942    -.257107
        L15D.  |  -.3645519   .1519838    -2.40   0.017    -.6632696   -.0658341
        L16D.  |   .0029936   .1580302     0.02   0.985    -.3076081    .3135954
        L17D.  |   .0422232   .1559561     0.27   0.787     -.264302    .3487483
        L18D.  |   .3199335   .1565006     2.04   0.042     .0123381    .6275288
        L19D.  |    -.07463   .0988972    -0.75   0.451    -.2690083    .1197484
        L20D.  |   .0625226   .0999685     0.63   0.532    -.1339614    .2590065
        L21D.  |  -.0436852   .1002131    -0.44   0.663    -.2406498    .1532795
        L22D.  |   .2231831   .0985078     2.27   0.024     .0295703     .416796
        L23D.  |  -.0081188   .0960409    -0.08   0.933    -.1968832    .1806456
        L24D.  |  -.2688582   .1616447    -1.66   0.097    -.5865639    .0488476
               |
     ln_fl_lf  |
          LD.  |   .1762398   .0704433     2.50   0.013     .0377865    .3146932
         L2D.  |  -.1356975   .0715783    -1.90   0.059    -.2763815    .0049866
         L3D.  |  -.1659446   .0715828    -2.32   0.021    -.3066375   -.0252517
         L4D.  |  -.0977864   .0709175    -1.38   0.169    -.2371718     .041599
         L5D.  |  -.1364495   .0722069    -1.89   0.059     -.278369      .00547
         L6D.  |  -.2270642   .0723796    -3.14   0.002    -.3693234   -.0848051
         L7D.  |  -.1332104   .0724525    -1.84   0.067    -.2756127    .0091919
         L8D.  |  -.2396185   .0727056    -3.30   0.001    -.3825182   -.0967187
         L9D.  |  -.1256755    .079465    -1.58   0.114    -.2818605    .0305095
        L10D.  |   -.180737   .0797732    -2.27   0.024    -.3375278   -.0239463
        L11D.  |   -.005726   .0808095    -0.07   0.944    -.1645537    .1531017
        L12D.  |   .0558537   .1334055     0.42   0.676    -.2063492    .3180565
        L13D.  |   .0173463   .1262683     0.14   0.891    -.2308286    .2655213
        L14D.  |   .2969825   .1275491     2.33   0.020     .0462901     .547675
        L15D.  |    .125207   .1266497     0.99   0.323    -.1237177    .3741316
        L16D.  |  -.0665773   .1288379    -0.52   0.606    -.3198027     .186648
        L17D.  |  -.1292395   .1273895    -1.01   0.311    -.3796182    .1211391
        L18D.  |  -.2883037   .1278108    -2.26   0.025    -.5395104    -.037097
        L24D.  |   .2278015   .1255369     1.81   0.070     -.018936    .4745389
               |
         date  |  -8.65e-06   3.19e-06    -2.72   0.007    -.0000149   -2.39e-06
        _cons  |   .0058495   .0022338     2.62   0.009     .0014592    .0102399
-------------------------------------------------------------------------------

. predict res, residual
(469 missing values generated)

. ac res, saving(p4_ac.gph, replace)
(file p4_ac.gph saved)

. pac res, saving(p4_pac.gph, replace)
(file p4_pac.gph saved)

. graph combine p4_ac.gph p4_pac.gph, saving(p4_combo.gph, replace)
(file p4_combo.gph saved)

. estat bgodfrey, lag(1/48)

Breusch-Godfrey LM test for autocorrelation
```

lags(p)	chi2	df	Prob > chi2
1	0.617	1	0.4321
2	1.630	2	0.4427

```
      3   |         1.639          3                  0.6506
      4   |         1.665          4                  0.7970
      5   |         1.730          5                  0.8850
      6   |         2.757          6                  0.8387
      7   |         8.252          7                  0.3109
      8   |         8.536          8                  0.3830
      9   |         8.707          9                  0.4648
     10   |         8.803         10                  0.5509
     11   |         9.015         11                  0.6205
     12   |        10.913         12                  0.5364
     13   |        12.697         13                  0.4715
     14   |        12.775         14                  0.5443
     15   |        14.075         15                  0.5198
     16   |        15.212         16                  0.5091
     17   |        15.284         17                  0.5751
     18   |        18.315         18                  0.4351
     19   |        18.317         19                  0.5014
     20   |        19.893         20                  0.4647
     21   |        19.920         21                  0.5263
     22   |        20.203         22                  0.5704
     23   |        20.218         23                  0.6287
     24   |        20.362         24                  0.6760
     25   |        21.112         25                  0.6864
     26   |        21.381         26                  0.7221
     27   |        23.290         27                  0.6693
     28   |        24.359         28                  0.6624
     29   |        25.322         29                  0.6615
     30   |        27.716         30                  0.5855
     31   |        28.706         31                  0.5846
     32   |        28.728         32                  0.6330
     33   |        29.272         33                  0.6533
     34   |        30.894         34                  0.6207
     35   |        30.897         35                  0.6666
     36   |        33.834         36                  0.5720
     37   |        35.071         37                  0.5597
     38   |        35.519         38                  0.5847
     39   |        38.229         39                  0.5049
     40   |        38.448         40                  0.5402
     41   |        38.548         41                  0.5801
     42   |        39.001         42                  0.6034
     43   |        39.107         43                  0.6408
     44   |        39.122         44                  0.6804
     45   |        39.431         45                  0.7061
     46   |        39.812         46                  0.7278
     47   |        40.011         47                  0.7550
     48   |        40.617         48                  0.7664
------------------------------------------------------------
                  H0: no serial correlation

.
. *5
. reg d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1)

      Source |       SS           df       MS      Number of obs   =       380
-------------+----------------------------------   F(5, 374)       =      2.97
       Model |  .00146591         5  .000293182   Prob > F        =    0.0122
    Residual |  .036972226       374  .000098856   R-squared       =    0.0381
-------------+----------------------------------   Adj R-squared   =    0.0253
       Total |  .038438136       379  .00010142    Root MSE        =    .00994

------------------------------------------------------------------------------
D.           |
ln_fl_nonf~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ln_fl_bp  |
         D1. |  -.0043445   .0035864    -1.21   0.227    -.0113965    .0027075
         LD. |  -.0115113   .0040594    -2.84   0.005    -.0194935   -.0035291
        L2D. |   .0019871   .0041056     0.48   0.629    -.0060858      .01006
        L3D. |  -.0011778   .0040768    -0.29   0.773    -.0091941    .0068385
        L4D. |  -.0028262   .0036121    -0.78   0.434    -.0099287    .0042763
             |
       _cons |   .0015358   .0005101     3.01   0.003     .0005328    .0025387
------------------------------------------------------------------------------

. newey d.ln_fl_nonfarm l(0/4)d.ln_fl_bp if tin(1948m1,2020m1), lag(4)

Regression with Newey-West standard errors      Number of obs     =        380
maximum lag: 4                                  F(  5,        374) =       4.01
                                                Prob > F          =     0.0015

------------------------------------------------------------------------------
D.           |             Newey-West
ln_fl_nonf~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   ln_fl_bp  |
         D1. |  -.0043445    .003622    -1.20   0.231    -.0114665    .0027776
         LD. |  -.0115113   .0036606    -3.14   0.002    -.0187093   -.0043133
        L2D. |   .0019871   .0043475     0.46   0.648    -.0065616    .0105358
        L3D. |  -.0011778    .004813    -0.24   0.807    -.0106416     .008286
        L4D. |  -.0028262    .003664    -0.77   0.441    -.0100308    .0043783
             |
       _cons |   .0015358   .0004154     3.70   0.000     .0007189    .0023526
------------------------------------------------------------------------------

.
```

```
. log close
      name:  <unnamed>
       log:  /Users/guslipkin/Documents/Spring2020/CAP 4763 ~ Time Series/Problem S
> ets/Problem Set 2/Problem Set 1.smcl
  log type:  smcl
 closed on:  26 Feb 2021, 18:09:11
```