Time Series Modeling and Forecasting **Spring 2019 Midterm**

The questions and Stata output below relate to three monthly non-seasonally adjusted time series from January 1990 through December 2017. Variable definitions are:

- fl_unemprate_m: Florida unemployment fate.
- us_unemprate_m: US unemployment rate.
- fl_bldpmt_m: Florida building permits issued, in hundreds of thousands

Part A: Time Series Basics and Static Models

1) The first model in the Stata output regresses the unemployment rate in Florida on the US unemployment rate. The second adds month indicators and a linear time trend.

a) What is the purpose of adding the month indicators and the time trend?

b) What do you make of the change in the coefficient on US unemployment and its standard error that occurred when month indicators and a time trend were added?

2) Nonstationarity

2a) What is a non-stationary process and why do we need to be wary of them?

2b) Interpret the partial autocorrelogram and Dickey-Fuller test results for the Florida unemployment rate that follow the second regression model.

3) The third regression model in the output regresses the first difference of the unemployment rate in Florida on the first difference of the US unemployment rate, including month indicators and a time trend.

a) The time trend was much smaller and less statistically significant in the third model than in the second model. What do you make of that?

b) Compare the coefficients on US unemployment in the second and third models. What likely explains the difference?

c) Interpret the Breusch-Godfrey test results that follow estimation of the third model.

d) In November 2017, the Florida unemployment rate was 3.8 and the US unemployment rate was 3.9. In December 2017, date was 695 and the US unemployment rate was 3.9. Using the third regression, what are the predicted values of the change in Florida unemployment rate and the Florida unemployment rate in December 2017? Show your work.

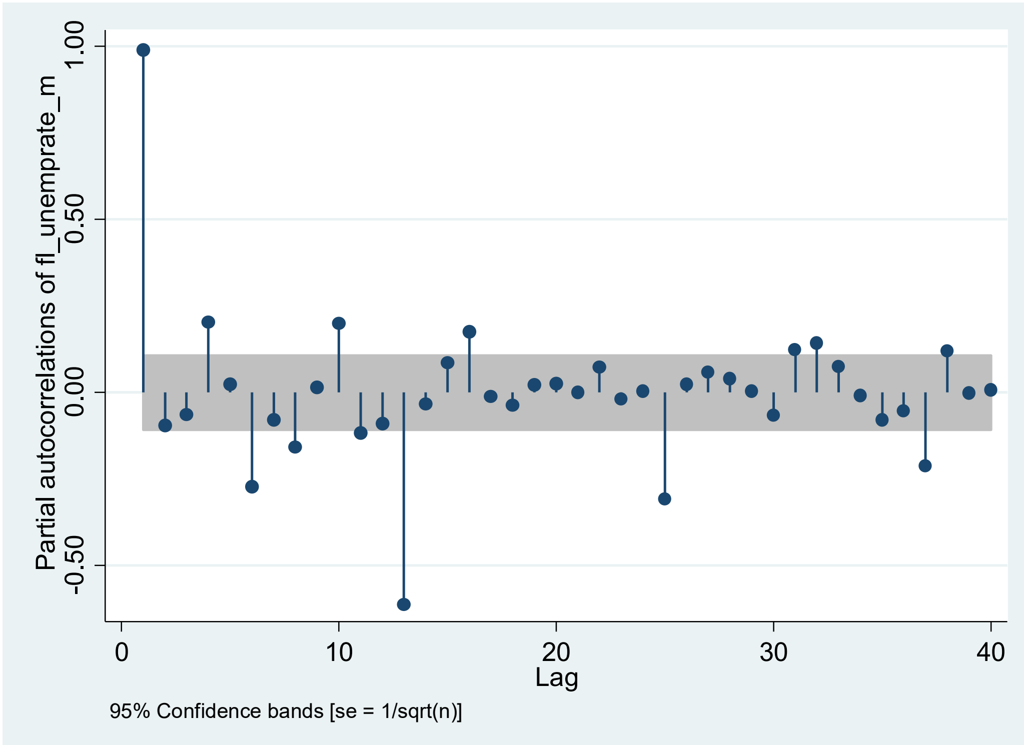
Part B: Model Selection

The Stata output for Part B contains four ARDL models relating the unemployment rate in Florida to the US unemployment rate and Florida building permits (in hundreds of thousands). Thoroughly make the case that Model 4 is the best of them.

Stata Results Log – Graphs Added

```
. import delimited using "fl and us monthly data.csv"
(11 vars, 338 obs)

. gen date=ym(year,month)
. tsset date
        time variable:  date, 360 to 697
                delta:  1 unit
. format date %tm
. replace fl_bldpmt_m=fl_bldpmt_m/100000
variable fl_bldpmt_m was int now float
(337 real changes made)

.
. **Part A: Time Series Modeling
.
. reg fl_unemprate_m us_unemprate_m if tin(1990m1,2017m12)
      Source |       SS           df       MS      Number of obs   =       336
-------------+----------------------------------   F(1, 334)       =   3624.90
       Model |  1373.01017         1  1373.01017   Prob > F        =    0.0000
    Residual |  126.509734       334   .37877166   R-squared       =    0.9156
-------------+----------------------------------   Adj R-squared   =    0.9154
       Total |   1499.5199       335  4.47617882   Root MSE        =    .61544
--------------------------------------------------------------------------------
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
us_unemprate_m |   1.280026   .0212604    60.21   0.000     1.238205    1.321847
         _cons |  -1.664704   .1316682   -12.64   0.000    -1.923707     -1.4057
--------------------------------------------------------------------------------

. reg fl_unemprate_m us_unemprate_m i.month date if tin(1990m1,2017m12)
      Source |       SS           df       MS      Number of obs   =       336
-------------+----------------------------------   F(13, 322)      =    460.66
       Model |  1423.00571        13  109.461978   Prob > F        =    0.0000
    Residual |   76.514196       322  .237621727   R-squared       =    0.9490
-------------+----------------------------------   Adj R-squared   =    0.9469
       Total |   1499.5199       335  4.47617882   Root MSE        =    .48746
--------------------------------------------------------------------------------
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
us_unemprate_m |   1.326111    .017358    76.40   0.000     1.291961     1.36026
         month |
            2  |  -.1012826   .1302994    -0.78   0.438    -.3576282    .1550631
            3  |   .0658376   .1304181     0.50   0.614    -.1907416    .3224168
            4  |   .5238028   .1310942     4.00   0.000     .2658936     .781712
            5  |   .6580757   .1310663     5.02   0.000     .4002212    .9159302
            6  |   .5810037   .1304729     4.45   0.000     .3243166    .8376907
            7  |   .7009909    .130462     5.37   0.000     .4443255    .9576564
            8  |   .9560773   .1307372     7.31   0.000     .6988704    1.213284
            9  |   1.081505   .1311109     8.25   0.000     .8235628    1.339447
           10  |   1.032552   .1313954     7.86   0.000     .7740497    1.291054
           11  |   .8967929   .1313044     6.83   0.000       .63847    1.155116
           12  |   .6858793   .1312625     5.23   0.000     .4276389    .9441196
          date |  -.0008107   .0002771    -2.93   0.004    -.0013558   -.0002655
         _cons |  -2.103154   .1944202   -10.82   0.000    -2.485648    -1.72066
--------------------------------------------------------------------------------
```

```
. pac fl_unemprate_m, saving(pacflunemp, replace)
(file pacflunemp.gph saved)
```




```
. dfuller fl_unemprate_m, trend regress lags(12)
Augmented Dickey-Fuller test for unit root         Number of obs   =       323
                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.825            -3.987            -3.427            -3.130
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0153
------------------------------------------------------------------------------
D.fl_unemp~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
fl_unempra~m |
         L1. |  -.0245363   .0064149    -3.82   0.000    -.0371588   -.0119138
         LD. |   .0426095   .0447195     0.95   0.341    -.0453849    .1306038
        L2D. |   .0931672   .0447301     2.08   0.038      .005152    .1811824
        L3D. |  -.0433071   .0450679    -0.96   0.337     -.131987    .0453728
        L4D. |   .0097457   .0446838     0.22   0.827    -.0781785    .0976699
        L5D. |   .0925232    .044661     2.07   0.039      .004644    .1804024
        L6D. |    .021341   .0448711     0.48   0.635    -.0669518    .1096338
        L7D. |   .0831795   .0448882     1.85   0.065     -.005147    .1715059
        L8D. |   .0061132   .0449954     0.14   0.892    -.0824241    .0946505
        L9D. |  -.0929745   .0449895    -2.07   0.040    -.1815002   -.0044489
       L10D. |   .0220614   .0450937     0.49   0.625    -.0666693    .1107922
       L11D. |   .0518429   .0449283     1.15   0.249    -.0365623    .1402481
       L12D. |   .6143788   .0451481    13.61   0.000      .525541    .7032165
      _trend |    .000068   .0001399     0.49   0.627    -.0002073    .0003434
       _cons |   .1295176   .0443752     2.92   0.004     .0422007    .2168345
------------------------------------------------------------------------------
```

```
. reg d.fl_unemprate_m d.us_unemprate_m i.month date if tin(1990m1,2017m12)

      Source |       SS           df       MS      Number of obs   =       335
-------------+----------------------------------   F(13, 321)      =    157.85
       Model |  29.4230229        13  2.26330945   Prob > F        =    0.0000
    Residual |  4.60252841       321  .014338095   R-squared       =    0.8647
-------------+----------------------------------   Adj R-squared   =    0.8593
       Total |  34.0255513       334  .101872908   Root MSE        =    .11974

------------------------------------------------------------------------------
D.           |
fl_unempra~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
us_unempra~m |
         D1. |   .9858471   .0377944    26.08   0.000     .9114911    1.060203
       month |
          2  |   .2509459   .0486518     5.16   0.000     .1552292    .3466625
          3  |   .4889657   .0512203     9.55   0.000     .3881959    .5897355
          4  |   .6850209   .0597572    11.46   0.000     .5674556    .8025862
          5  |   .5351038   .0447468    11.96   0.000     .4470698    .6231378
          6  |   .4622925   .0358577    12.89   0.000     .3917466    .5328384
          7  |   .5208137   .0447399    11.64   0.000     .4327931    .6088342
          8  |   .5708447   .0517264    11.04   0.000     .4690791    .6726102
          9  |   .4460446   .0513022     8.69   0.000     .3451137    .5469755
         10  |    .300827   .0488244     6.16   0.000     .2047707    .3968833
         11  |   .2747806   .0439874     6.25   0.000     .1882406    .3613205
         12  |   .1923321   .0445383     4.32   0.000     .1047083     .279956
        date |   2.23e-06   .0000679     0.03   0.974    -.0001313    .0001357
       _cons |  -.3967368   .0545516    -7.27   0.000    -.5040606    -.289413
------------------------------------------------------------------------------

. estat bgodfrey, lags(1,12,24)
Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.902               1                   0.3422
      12     |         25.816              12                   0.0114
      24     |         34.964              24                   0.0689
---------------------------------------------------------------------------
                        H0: no serial correlation
```

**Part B: Model Selection

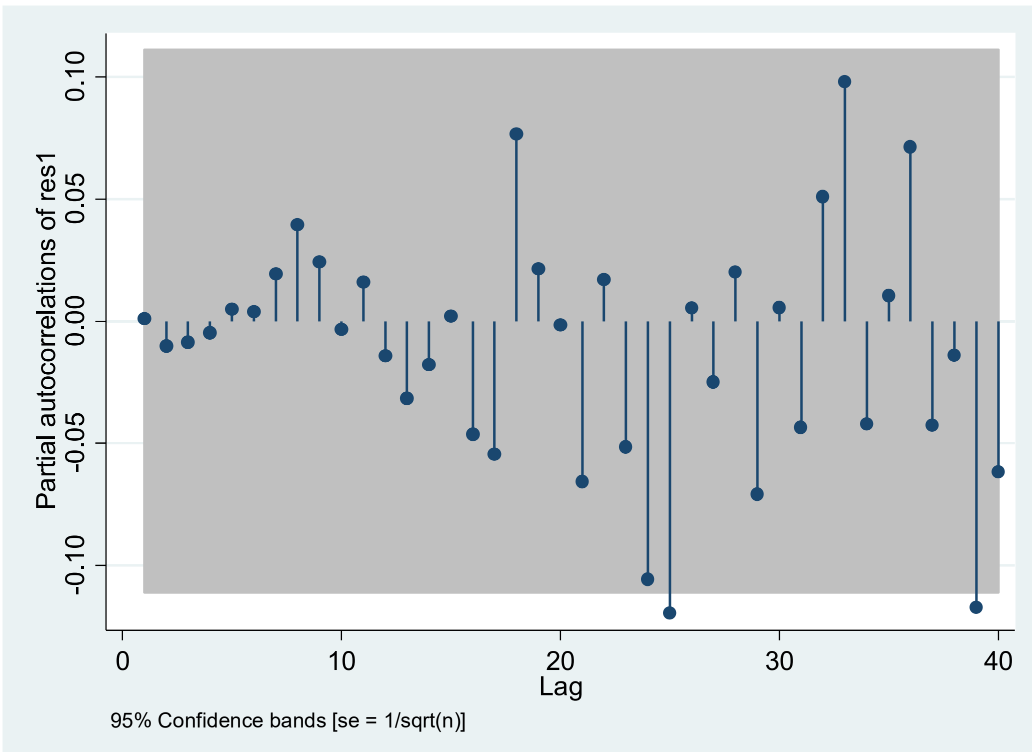
Model 1

```
. crossfold reg d.fl_unemprate_m l(1/24)d.fl_unemprate_m l(0/24)d.us_unemprate_m
l(0/24)d.fl_bldpmt_m i.month date if tin(1992m1,2017m12) , k(10)
             |      RMSE
-------------+-----------
        est1 |  .1331984
        est2 |  .1157289
        est3 |  .1379295
        est4 |  .1439543
        est5 |  .1148643
        est6 |  .1286004
        est7 |  .1215974
        est8 |  .1118732
        est9 |  .1738664
       est10 |  .1210292

. *Calculate the root of the MSE averaged over k folds
. *define k as the number of folds
. scalar define k=10

. *calculate the sum of the k MSEs
. matrix kMSE=r(est)'*r(est)

. *Calculate the root of the MSE averaged over k folds
. scalar krmse=(el(kMSE,1,1)/k)^.5

. *List the answer
. scalar list krmse
     krmse =   .1314509

. *Drop the matrix and scalar defined for the problem
. matrix drop kMSE

. scalar drop krmse

.
. loocv reg d.fl_unemprate_m l(1/24)d.fl_unemprate_m ///
>         l(0/24)d.us_unemprate_m l(0/24)d.fl_bldpmt_m ///
>         i.month date if tin(1992m1,2017m12)

 Leave-One-Out Cross-Validation Results
-----------------------------------------
         Method          |    Value
-------------------------+---------------
Root Mean Squared Errors |   .12998808
Mean Absolute Errors     |   .09923896
Pseudo-R2                |   .83025246
-----------------------------------------
```

```
. reg d.fl_unemprate_m l(1/24)d.fl_unemprate_m l(0/24)d.us_unemprate_m ///
     l(0/24)d.fl_bldpmt_m i.month date if tin(1992m1,2017m12)

      Source |       SS           df       MS      Number of obs   =       311
-------------+----------------------------------   F(86, 224)      =     27.87
       Model |  29.0087693        86   .33731127   Prob > F        =    0.0000
    Residual |  2.71084518       224  .012101987   R-squared       =    0.9145
-------------+----------------------------------   Adj R-squared   =    0.8817
       Total |  31.7196144       310  .102321337   Root MSE        =    .11001

------------------------------------------------------------------------------
D.           |
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
fl_unemprate_m |
          LD. |  -.0235661   .0665507    -0.35   0.724    -.1547115    .1075794
         L2D. |   .1451443   .0667362     2.17   0.031     .0136332    .2766555
         L3D. |  -.0211972   .0673119    -0.31   0.753    -.1538428    .1114484
         L4D. |  -.1284633   .0680479    -1.89   0.060    -.2625592    .0056325
         L5D. |  -.0514685   .0690339    -0.75   0.457    -.1875075    .0845705
         L6D. |  -.0054904   .0686087    -0.08   0.936    -.1406915    .1297106
         L7D. |   .0334073   .0690403     0.48   0.629    -.1026443    .1694588
         L8D. |  -.1176187   .0693418    -1.70   0.091    -.2542644     .019027
         L9D. |  -.0235745   .0699749    -0.34   0.737    -.1614678    .1143188
        L10D. |   .0221167   .0666626     0.33   0.740    -.1092494    .1534828
        L11D. |  -.0407309   .0666194    -0.61   0.542    -.1720117    .0905499
        L12D. |   .1174373    .068334     1.72   0.087    -.0172223     .252097
        L13D. |  -.0077621   .0686095    -0.11   0.910    -.1429648    .1274405
        L14D. |  -.1015379   .0690218    -1.47   0.143    -.2375531    .0344772
        L15D. |  -.1534794   .0694948    -2.21   0.028    -.2904267   -.0165321
        L16D. |   .0659237   .0695879     0.95   0.344    -.0712069    .2030544
        L17D. |  -.0060275   .0694083    -0.09   0.931    -.1428042    .1307493
        L18D. |  -.0563072   .0704327    -0.80   0.425    -.1951027    .0824882
        L19D. |  -.1378448   .0709156    -1.94   0.053    -.2775919    .0019024
        L20D. |  -.0024464   .0704269    -0.03   0.972    -.1412303    .1363375
        L21D. |    .022218   .0689642     0.32   0.748    -.1136836    .1581196
        L22D. |  -.0332752   .0682264    -0.49   0.626    -.1677229    .1011725
        L23D. |   .0774672   .0677268     1.14   0.254     -.055996    .2109304
        L24D. |   .0266005   .0678182     0.39   0.695    -.1070427    .1602438
us_unemprate_m |
          D1. |    .955707   .0467436    20.45   0.000     .8635935    1.047821
          LD. |   .0124089   .0792622     0.16   0.876     -.143786    .1686038
         L2D. |  -.0717746   .0796528    -0.90   0.369    -.2287393    .0851901
         L3D. |   .0483615    .079692     0.61   0.545    -.1086805    .2054034
         L4D. |   .0627238   .0802934     0.78   0.436    -.0955033    .2209508
         L5D. |   .0385137   .0811932     0.47   0.636    -.1214865     .198514
         L6D. |   .0437029    .080632     0.54   0.588    -.1151913    .2025971
         L7D. |   .0718758   .0797639     0.90   0.368    -.0853078    .2290595
         L8D. |   .1926321   .0796835     2.42   0.016      .035607    .3496572
         L9D. |   -.062427   .0804939    -0.78   0.439    -.2210492    .0961951
        L10D. |  -.0836891   .0797193    -1.05   0.295    -.2407847    .0734065
        L11D. |   .0264037   .0789281     0.33   0.738    -.1291329    .1819403
        L12D. |  -.1586282   .0799503    -1.98   0.048    -.3161792   -.0010772
        L13D. |  -.0400107   .0803652    -0.50   0.619    -.1983792    .1183578
        L14D. |   .1479014   .0815146     1.81   0.071    -.0127321    .3085349
        L15D. |   .1761673   .0818518     2.15   0.032     .0148691    .3374654
        L16D. |  -.0454148   .0816384    -0.56   0.579    -.2062924    .1154627
        L17D. |  -.0167479   .0810087    -0.21   0.836    -.1763846    .1428888
        L18D. |   .1226048   .0821026     1.49   0.137    -.0391876    .2843971
        L19D. |   .1714005   .0820161     2.09   0.038     .0097786    .3330224
        L20D. |   .0150449   .0809207     0.19   0.853    -.1444184    .1745082
```

```
        L21D. |  -.0458833   .0802155    -0.57   0.568    -.2039569    .1121902
        L22D. |   .0357954   .0798371     0.45   0.654    -.1215324    .1931231
        L23D. |  -.1139502   .0810678    -1.41   0.161    -.2737033    .0458029
        L24D. |  -.1016386   .0806861    -1.26   0.209    -.2606394    .0573623
  fl_bldpmt_m |
          D1. |   .7579252   .5332993     1.42   0.157    -.2930003    1.808851
          LD. |  -.7520867   .6262269    -1.20   0.231    -1.986136    .4819629
         L2D. |  -1.429791   .6348991    -2.25   0.025     -2.68093   -.1786519
         L3D. |  -.4067094   .6384072    -0.64   0.525    -1.664762    .8513429
         L4D. |  -2.206063   .6404142    -3.44   0.001     -3.46807   -.9440557
         L5D. |  -1.572978   .6517656    -2.41   0.017    -2.857355   -.2886017
         L6D. |  -.3398947   .6485971    -0.52   0.601    -1.618027    .9382379
         L7D. |    .306994   .6390747     0.48   0.631    -.9523736    1.566361
         L8D. |  -1.418312   .6375356    -2.22   0.027    -2.674647   -.1619776
         L9D. |  -.4946929   .6449166    -0.77   0.444    -1.765573    .7761868
        L10D. |   -.598325   .6511689    -0.92   0.359    -1.881526    .6848756
        L11D. |   -.771069   .6554464    -1.18   0.241    -2.062699    .5205609
        L12D. |  -.7983019   .6646229    -1.20   0.231    -2.108015    .5114112
        L13D. |  -.2642365   .6626575    -0.40   0.690    -1.570077    1.041604
        L14D. |  -.2676502   .6639671    -0.40   0.687    -1.576071    1.040771
        L15D. |  -1.560773   .6624768    -2.36   0.019    -2.866257   -.2552892
        L16D. |   .4478867   .6745288     0.66   0.507    -.8813473    1.777121
        L17D. |   -.183118   .6792566    -0.27   0.788    -1.521668    1.155432
        L18D. |  -.6444352   .6808455    -0.95   0.345    -1.986117    .6972464
        L19D. |  -.9463943   .6871076    -1.38   0.170    -2.300416    .4076275
        L20D. |  -1.114874   .6918417    -1.61   0.108    -2.478225    .2484763
        L21D. |  -1.651977    .675783    -2.44   0.015    -2.983682   -.3202719
        L22D. |  -.8962605   .6761209    -1.33   0.186    -2.228632    .4361107
        L23D. |  -1.169693   .6612269    -1.77   0.078    -2.472714    .1333277
        L24D. |  -.4624015   .5701709    -0.81   0.418    -1.585987    .6611836
        month |
           2  |   .1848949   .1292539     1.43   0.154    -.0698143     .439604
           3  |   .3293838   .1743256     1.89   0.060    -.0141441    .6729116
           4  |   .4956766   .1947931     2.54   0.012     .1118152     .879538
           5  |   .4608421   .1573362     2.93   0.004     .1507936    .7708905
           6  |   .4412186   .1296285     3.40   0.001     .1857714    .6966659
           7  |   .3068799   .1218611     2.52   0.012     .0667391    .5470206
           8  |   .2166928   .1477249     1.47   0.144    -.0744155    .5078012
           9  |   .2437908   .1680322     1.45   0.148    -.0873352    .5749168
          10  |   .5036017   .1853133     2.72   0.007     .1384213     .868782
          11  |   .5412636   .1652311     3.28   0.001     .2156575    .8668698
          12  |   .2848855   .1246709     2.29   0.023     .0392076    .5305634
         date |   .0000449   .0000724     0.62   0.535    -.0000976    .0001875
        _cons |  -.3632501   .1144721    -3.17   0.002      -.58883   -.1376702
------------------------------------------------------------------------------

. estat ic
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        311 -86.30552   296.1739      87   -418.3478  -92.98584
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.
```

```
. estat bgodfrey, lags(1,12,24)
Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.015               1                   0.9023
      12     |          7.499              12                   0.8229
      24     |         34.001              24                   0.0846
---------------------------------------------------------------------------
                        H0: no serial correlation

. predict res1, residual
(27 missing values generated)
. pac res1 if tin(1992m1,2017m12), saving(pacres1, replace)
(file pacres1.gph saved)
```

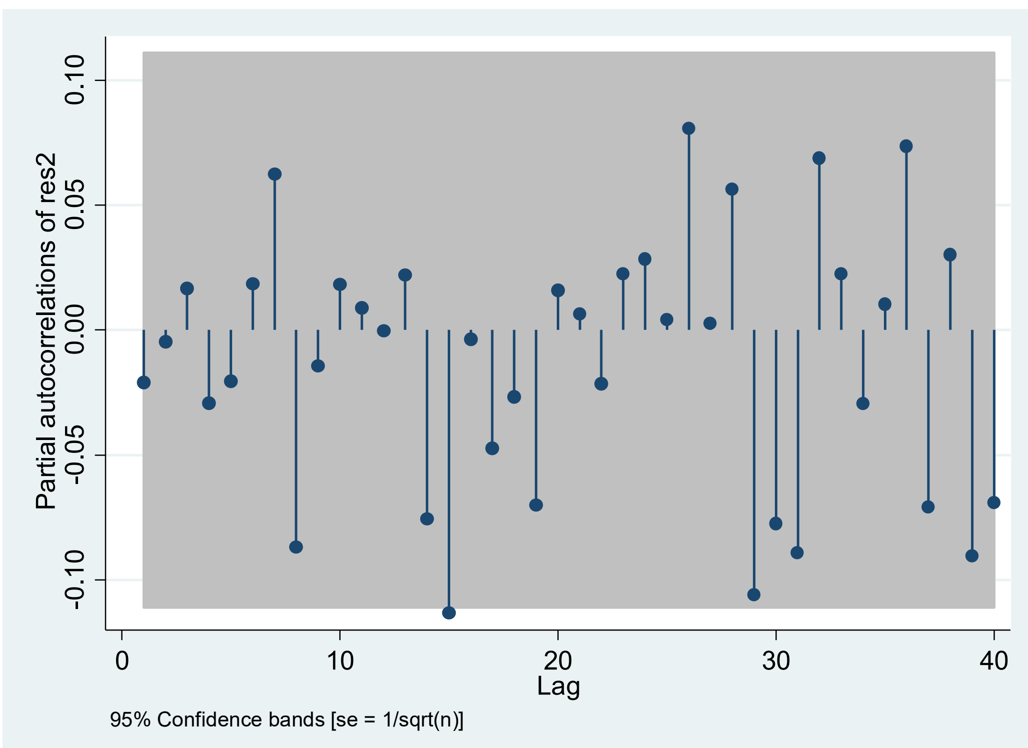


***Model 2**

```
. crossfold reg d.fl_unemprate_m l(1/6,12)d.fl_unemprate_m
l(0/6,12)d.us_unemprate_m l(1/6,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12) ,
k(10)

             |      RMSE
-------------+-----------
        est1 |  .1283137
        est2 |  .1245017
        est3 |  .1045709
        est4 |  .1090042
        est5 |  .1255636
        est6 |   .108334
        est7 |  .1640762
        est8 |  .1190933
        est9 |  .1143318
       est10 |   .125047

. *Calculate the root of the MSE averaged over k folds
. *define k as the number of folds
. scalar define k=10

. *calculate the sum of the k MSEs
. matrix kMSE=r(est)'*r(est)

. *Calculate the root of the MSE averaged over k folds
. scalar krmse=(el(kMSE,1,1)/k)^.5

. *List the answer
. scalar list krmse
     krmse =  .12332772

. *Drop the matrix and scalar defined for the problem
. matrix drop kMSE

. scalar drop krmse


. loocv reg d.fl_unemprate_m l(1/6,12)d.fl_unemprate_m l(0/6,12)d.us_unemprate_m
l(1/6,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)

 Leave-One-Out Cross-Validation Results
-----------------------------------------
         Method          |    Value
-------------------------+---------------
Root Mean Squared Errors |   .12024645
Mean Absolute Errors     |   .08705196
Pseudo-R2                |   .85433242
-----------------------------------------
```

```
. reg d.fl_unemprate_m l(1/6,12)d.fl_unemprate_m l(0/6,12)d.us_unemprate_m
l(1/6,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)

      Source |       SS           df       MS      Number of obs   =       312
-------------+----------------------------------   F(33, 278)      =     67.14
       Model |  28.7732727        33  .871917355   Prob > F        =    0.0000
    Residual |  3.61018866       278  .01298629    R-squared       =    0.8885
-------------+----------------------------------   Adj R-squared   =    0.8753
       Total |  32.3834614       311  .104126885   Root MSE        =    .11396

--------------------------------------------------------------------------------
D.             |
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
fl_unemprate_m |
           LD. |   .0112768   .0585922     0.19   0.848     -.104064    .1266177
          L2D. |    .162918   .0589143     2.77   0.006     .0469431    .2788928
          L3D. |   .0023537   .0600798     0.04   0.969    -.1159154    .1206227
          L4D. |   -.067508   .0605607    -1.11   0.266    -.1867237    .0517078
          L5D. |  -.0600681   .0599647    -1.00   0.317    -.1781106    .0579743
          L6D. |  -.0348368   .0601734    -0.58   0.563    -.1532903    .0836167
         L12D. |    .139398   .0612679     2.28   0.024       .01879    .2600059
us_unemprate_m |
           D1. |   .9649217   .0421059    22.92   0.000     .8820348    1.047809
           LD. |  -.0617445   .0704599    -0.88   0.382    -.2004471    .0769581
          L2D. |  -.0986369   .0705706    -1.40   0.163    -.2375576    .0402838
          L3D. |    .057523   .0711015     0.81   0.419    -.0824427    .1974887
          L4D. |   .0582209   .0715153     0.81   0.416    -.0825594    .1990012
          L5D. |   .0403882    .071411     0.57   0.572    -.1001867    .1809631
          L6D. |   .1094476   .0716997     1.53   0.128    -.0316957    .2505908
         L12D. |  -.2129583   .0715949    -2.97   0.003    -.3538954   -.0720212
   fl_bldpmt_m |
           LD. |  -1.074752    .490455    -2.19   0.029     -2.04023    -.109275
          L2D. |  -1.055492   .5772423    -1.83   0.069    -2.191813    .0808288
          L3D. |  -.5130382   .5764118    -0.89   0.374    -1.647724    .6216481
          L4D. |  -1.871989   .5752531    -3.25   0.001    -3.004394   -.7395833
          L5D. |  -1.528399   .5769154    -2.65   0.009    -2.664077   -.3927218
          L6D. |  -.4263497   .5000329    -0.85   0.395    -1.410681     .557982
         L12D. |  -.2224729   .4291563    -0.52   0.605    -1.067282    .6223359
         month |
            2  |   .1740037    .077361     2.25   0.025      .021716    .3262914
            3  |   .2766958   .0922322     3.00   0.003     .0951336    .4582581
            4  |   .3807327   .1120294     3.40   0.001      .160199    .6012665
            5  |   .3056605   .0950786     3.21   0.001     .1184952    .4928259
            6  |   .2981456   .0858179     3.47   0.001     .1292102     .467081
            7  |   .3118646   .0855015     3.65   0.000      .143552    .4801772
            8  |   .3455286    .092639     3.73   0.000     .1631656    .5278916
            9  |   .2197737   .0917152     2.40   0.017     .0392293    .4003182
           10  |    .181251   .0872345     2.08   0.039     .0095269    .3529751
           11  |   .1586501   .0731719     2.17   0.031     .0146087    .3026914
           12  |   .0632388   .0628941     1.01   0.316    -.0605705     .187048
         _cons |  -.2291838   .0640504    -3.58   0.000    -.3552691   -.1030985
--------------------------------------------------------------------------------
```

```
 estat ic
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        312 -89.31339   252.9331      34   -437.8662  -310.6041
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.

. estat bgodfrey, lags(1,12,24)
Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.443               1                   0.1181
      12     |         11.215              12                   0.5106
      24     |         20.408              24                   0.6734
---------------------------------------------------------------------------
                        H0: no serial correlation

. predict res2, residual
(15 missing values generated)
. pac res2 if tin(1992m1,2017m12), saving(pacres2, replace)
(file pacres2.gph saved)
```

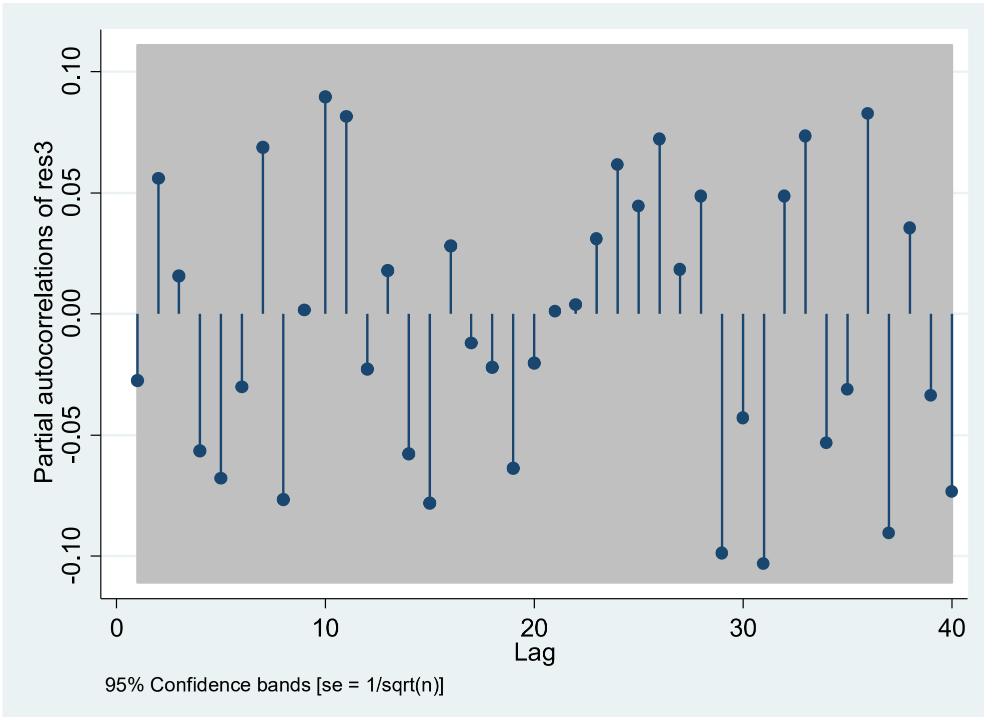


***Model 3**

```
. crossfold reg d.fl_unemprate_m l(1/2,12)d.fl_unemprate_m
l(0,1,12)d.us_unemprate_m l(1/2,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12) ,
k(10)

             |      RMSE
-------------+-----------
        est1 |   .097779
        est2 |  .1045147
        est3 |  .1132839
        est4 |  .0780219
        est5 |  .1045674
        est6 |  .1005156
        est7 |  .1283471
        est8 |   .139189
        est9 |  .1798981
       est10 |  .1271304

. *Calculate the root of the MSE averaged over k folds
. *define k as the number of folds
. scalar define k=10

. *calculate the sum of the k MSEs
. matrix kMSE=r(est)'*r(est)

. *Calculate the root of the MSE averaged over k folds
. scalar krmse=(el(kMSE,1,1)/k)^.5

. *List the answer
. scalar list krmse
     krmse =  .12033888

. *Drop the matrix and scalar defined for the problem
. matrix drop kMSE

. scalar drop krmse

.
. loocv reg d.fl_unemprate_m l(1/2,12)d.fl_unemprate_m l(0,1,12)d.us_unemprate_m
l(1/2,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)


 Leave-One-Out Cross-Validation Results
-----------------------------------------
         Method          |    Value
-------------------------+---------------
Root Mean Squared Errors |   .11968351
Mean Absolute Errors     |   .08572123
Pseudo-R2                |   .85543362
-----------------------------------------
```

```
. reg d.fl_unemprate_m l(1,2,12)d.fl_unemprate_m l(0,1,12)d.us_unemprate_m
l(1,2,12)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)

      Source |       SS           df       MS      Number of obs   =       312
-------------+----------------------------------   F(20, 291)      =    106.07
       Model |  28.4772607        20  1.42386304   Prob > F        =    0.0000
    Residual |  3.90620062       291   .01342337   R-squared       =    0.8794
-------------+----------------------------------   Adj R-squared   =    0.8711
       Total |  32.3834614       311  .104126885   Root MSE        =    .11586

--------------------------------------------------------------------------------
D.             |
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
fl_unemprate_m |
           LD. |   .0401622   .0567946     0.71   0.480    -.0716181    .1519425
          L2D. |   .0977518   .0330888     2.95   0.003     .0326281    .1628755
         L12D. |   .1620438   .0596513     2.72   0.007     .0446412    .2794464
us_unemprate_m |
           D1. |   .9650679   .0409797    23.55   0.000     .8844136    1.045722
           LD. |  -.0613548   .0687722    -0.89   0.373    -.1967088    .0739992
         L12D. |  -.2427502   .0700403    -3.47   0.001       -.3806   -.1049003
   fl_bldpmt_m |
           LD. |  -1.122741   .4749837    -2.36   0.019     -2.05758   -.1879017
          L2D. |  -.7763169   .4736132    -1.64   0.102    -1.708459    .1558248
         L12D. |   -.315547   .4179787    -0.75   0.451    -1.138192    .5070976
         month |
            2  |   .1424224   .0718922     1.98   0.049     .0009279     .283917
            3  |   .2428755    .076358     3.18   0.002     .0925916    .3931594
            4  |   .4271284    .092377     4.62   0.000     .2453167    .6089402
            5  |   .3284653   .0743268     4.42   0.000     .1821791    .4747515
            6  |   .3277668   .0520739     6.29   0.000     .2252776     .430256
            7  |   .3250683   .0707576     4.59   0.000     .1858068    .4643298
            8  |   .2816609   .0837511     3.36   0.001     .1168261    .4464956
            9  |   .2040033   .0785062     2.60   0.010     .0494915    .3585152
           10  |   .1271265   .0676047     1.88   0.061    -.0059297    .2601826
           11  |   .1350026   .0582989     2.32   0.021     .0202617    .2497434
           12  |   .0662858   .0557649     1.19   0.236    -.0434679    .1760395
         _cons |  -.2203456   .0589563    -3.74   0.000    -.3363805   -.1043108
--------------------------------------------------------------------------------

. estat ic
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        312 -89.31339   240.6395      21    -439.279  -360.6759
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.

. estat bgodfrey, lags(1,12,24)
Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.899               1                   0.0886
      12     |         14.433              12                   0.2739
      24     |         21.004              24                   0.6385
---------------------------------------------------------------------------
                        H0: no serial correlation
```

```
. predict res3, residual
(15 missing values generated)
. pac res3 if tin(1992m1,2017m12), saving(pacres3, replace)
(file pacres3.gph saved)
```



*** Model 4**

```
. crossfold reg d.fl_unemprate_m l(2,12)d.fl_unemprate_m l(0,12)d.us_unemprate_m
l(1,2)d.fl_bldpmt_m i.month if tin(1992m1,2017m12) , k(10)

             |      RMSE
-------------+-----------
        est1 |  .1008549
        est2 |  .1202172
        est3 |  .1029322
        est4 |  .1043395
        est5 |  .1010197
        est6 |  .1019215
        est7 |  .1067588
        est8 |  .1501051
        est9 |  .1922827
       est10 |   .099238

. *Calculate the root of the MSE averaged over k folds
. *define k as the number of folds
. scalar define k=10

. *calculate the sum of the k MSEs
. matrix kMSE=r(est)'*r(est)

. *Calculate the root of the MSE averaged over k folds
. scalar krmse=(el(kMSE,1,1)/k)^.5

. *List the answer
. scalar list krmse
     krmse =  .12142833

. *Drop the matrix and scalar defined for the problem
. matrix drop kMSE

. scalar drop krmse

.
. loocv reg d.fl_unemprate_m l(2,12)d.fl_unemprate_m l(0,12)d.us_unemprate_m
l(1,2)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)

 Leave-One-Out Cross-Validation Results
-----------------------------------------
         Method          |    Value
-------------------------+---------------
Root Mean Squared Errors |   .11873367
Mean Absolute Errors     |   .08478072
Pseudo-R2                |   .85768422
-----------------------------------------
```

```
. reg d.fl_unemprate_m l(2,12)d.fl_unemprate_m l(0,12)d.us_unemprate_m
l(1,2)d.fl_bldpmt_m i.month if tin(1992m1,2017m12)

      Source |       SS           df       MS      Number of obs   =       312
-------------+----------------------------------   F(17, 294)      =    125.42
       Model |  28.459242        17  1.67407306   Prob > F        =    0.0000
    Residual |  3.9242194       294  .013347685   R-squared       =    0.8788
-------------+----------------------------------   Adj R-squared   =    0.8718
       Total |  32.3834614       311  .104126885   Root MSE        =    .11553

------------------------------------------------------------------------------
D.            |
fl_unemprate_m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
fl_unemprate_m |
          L2D. |   .0944044   .0327543     2.88   0.004     .0299419    .1588669
         L12D. |   .1611948   .0590992     2.73   0.007     .0448838    .2775058
us_unemprate_m |
           D1. |   .9705587   .0403733    24.04   0.000     .8911015    1.050016
         L12D. |  -.2390609   .0689852    -3.47   0.001    -.3748284   -.1032935
   fl_bldpmt_m |
           LD. |  -1.094663   .4701631    -2.33   0.021    -2.019975    -.169351
          L2D. |  -.8090881   .4713098    -1.72   0.087    -1.736657    .1184806
         month |
            2  |     .12734   .0620228     2.05   0.041      .005275     .249405
            3  |   .2568056   .0751571     3.42   0.001     .1088914    .4047198
            4  |   .4578534   .0879281     5.21   0.000     .2848052    .6309016
            5  |   .3671634    .064647     5.68   0.000     .2399338     .494393
            6  |   .3445649   .0481676     7.15   0.000     .2497678    .4393619
            7  |    .337686   .0653737     5.17   0.000     .2090262    .4663457
            8  |   .3074798   .0796466     3.86   0.000     .1507301    .4642295
            9  |   .2385065   .0720884     3.31   0.001     .0966318    .3803812
           10  |   .1530087   .0634696     2.41   0.017     .0280963     .277921
           11  |    .155353   .0551332     2.82   0.005     .0468472    .2638588
           12  |   .0752292   .0547992     1.37   0.171    -.0326192    .1830776
               |
         _cons |  -.2380817   .0562047    -4.24   0.000    -.3486964   -.1274671
------------------------------------------------------------------------------

. estat ic
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        312 -89.31339   239.9216      18   -443.8431   -376.469
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.

. estat bgodfrey, lags(1,12,24)
Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.090               1                   0.7647
      12     |         12.312              12                   0.4210
      24     |         18.737              24                   0.7658
---------------------------------------------------------------------------
                        H0: no serial correlation
```

```
. predict res4, residual
(15 missing values generated)
. pac res4 if tin(1992m1,2017m12), saving(pacres4, replace)
(file pacres4.gph saved)
```