Final Exam

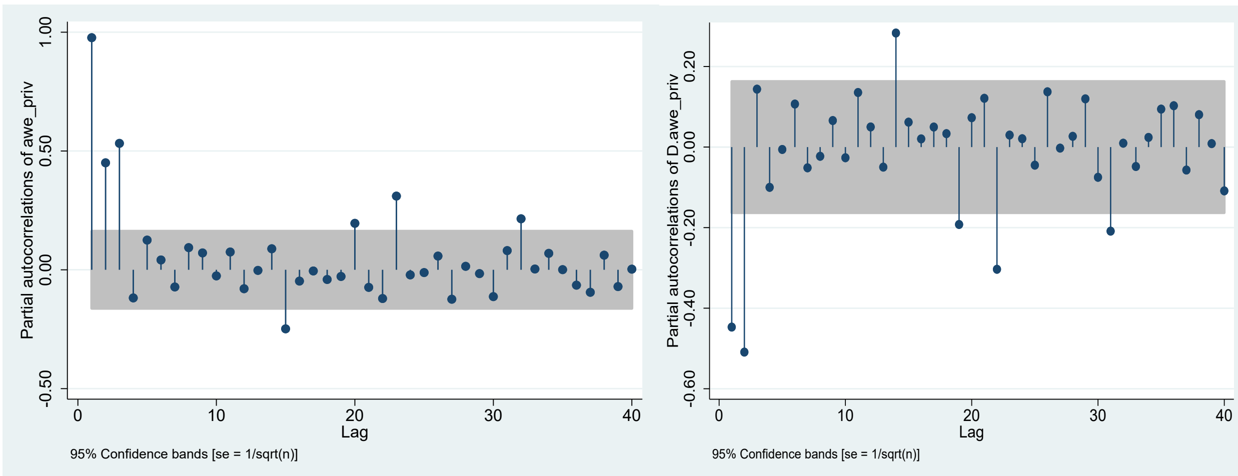
Instructions

- Answer the questions below on the answer sheet provided. Write only on the fronts of the pages.
- Organize your answers logically. Use scratch paper to work them out ahead of time if needed.
- Be NEAT! If it is too hard to read, it is wrong.
- Be concise. You will lose points for saying incorrect things as well as for not saying correct things.

1. Consider part 1 of the output provided. Interpret the PACs and Dickey-Fuller results. What do they imply for modeling average weekly earnings?
2. Part 2 of the output gives results for a "baseline" model. Why would we think of this as the baseline model for a one-step forecast in this case?
3. Consider the baseline model in part 2 of the output and the alternative model in part 3 of the output. Argue that the alternative model with a window size of 60 months is best.
4. Suppose you want to know the confidence interval for the change in next month's average weekly earnings associated with a change in the share of employment in leisure and hospitality. Should you use the output in part 3 or the output in part 4? Why?
5. Using the information in part 5 of the output, calculate the 90% empirical forecast interval for March 2019 average weekly earnings. Why not use the coefficients from part 3 of the output?
6. To keep work on question 5 simple, all variables are untransformed. Why would it make sense to take the log before modeling average weekly earnings? If we were working in logs what additional steps would you need to perform in the previous question?
7. Out of sample validation is crucial to protect against over fitting. What is overfitting? Why is standard K-fold cross validation potentially troublesome in a time series context? What is rolling window estimation and validation? How does it avoid the trouble suffered by with K-fold cross validation?
8. Suppose we want to explore models with alternative predictors and various lags. We used the GSREG package to do such things. Why did we use AIC, BIC, and out of sample RMSE to rank models with GSREG instead of the regular RMSE or R-Squared?
9. How would we best go about making a forecast for average weekly earnings for horizons 2, and 3?
10. What is a fan chart, and how would we make one for our forecasts?
11. How would the baseline model above be used to make a dynamic forecast for horizons 1, 2, and 3? What are the advantages and disadvantages of this relative to the method in the previous question?
12. How would a Vector Autoregressive Model (VAR) be used to make a dynamic forecast for horizons 1, 2, and 3?
13. Briefly, what does Christopher Sims have to do with VAR models and what was his critique about?
14. Rewrite the AR(1) model $y_t = ay_{t-1} + e_t$ (e is white noise and $0<a<1$) as an infinite MA model.
15. What is the Wold Representation Theorem and why is it foundational for forecasting?

The Stata output below pertains to models of monthly average weekly earnings for private sector employees in Florida (awe_priv). The baseline model is purely autoregressive. The alternative model includes the share of leisure and hospitality employment in total nonfarm employment (share_lh). All models include month indicators.

1. Assessing Stationarity



Dickey-Fuller Test for Average Weekly Earnings

Augmented Dickey-Fuller test for unit root   Number of obs = 133

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	0.332	-4.029	-3.446	-3.146

MacKinnon approximate p-value for Z(t) = 0.9964

Dickey-Fuller Test for *Difference* in Average Weekly Earnings

Augmented Dickey-Fuller test for unit root   Number of obs = 132

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.625	-4.029	-3.446	-3.146

MacKinnon approximate p-value for Z(t) = 0.0278

2. Baseline Model

```
      Source |       SS           df       MS      Number of obs   =       133
-------------+----------------------------------   F(23, 109)      =      7.00
       Model |  8709.02717        23  378.653355   Prob > F        =    0.0000
    Residual |  5898.44378       109  54.1141631   R-squared       =    0.5962
-------------+----------------------------------   Adj R-squared   =    0.5110
       Total |   14607.471       132  110.662659   Root MSE        =    7.3562

------------------------------------------------------------------------------
  D.awe_priv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    awe_priv |
         LD. |  -.6011393    .094644    -6.35   0.000    -.7887205    -.413558
        L2D. |  -.5196872   .1092459    -4.76   0.000     -.736209   -.3031654
        L3D. |  -.0015883   .1198929    -0.01   0.989    -.2392122    .2360356
        L4D. |  -.0460876   .1160451    -0.40   0.692    -.2760853    .1839101
        L5D. |   .0929756   .1156809     0.80   0.423    -.1363003    .3222514
        L6D. |   .2451245   .1134313     2.16   0.033     .0203074    .4699417
        L7D. |   .2386793    .110899     2.15   0.034     .0188812    .4584775
        L8D. |    .154619   .1099346     1.41   0.162    -.0632678    .3725059
        L9D. |    .282376   .1093647     2.58   0.011     .0656187    .4991332
       L10D. |   .0314288   .1116487     0.28   0.779    -.1898554     .252713
       L11D. |    .170758   .1010646     1.69   0.094    -.0295488    .3710647
       L12D. |  -.0850619   .0875797    -0.97   0.334     -.258642    .0885182
------------------------------------------------------------------------------
```

Note: Coefficients for month indicators and constant not shown to save space.

```
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        133 -501.1983  -440.8931      24    929.7862   999.1546
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          8.966               1                   0.0028
      12     |         26.578              12                   0.0089
---------------------------------------------------------------------------
                        H0: no serial correlation

. /*Rolling window results - Baseline Model
*Windows over 6 years not considered as there are only 12 years of data and leaving
out one year of lags plus a 6 year window leaves only 60 observations to fit.
  RWrmse72 =    8.86
  RWrmse60 =   10.46
  RWrmse48 =   11.16
  RWrmse36 =   13.91
```

3. Alternative Model

```
      Source |       SS           df       MS      Number of obs   =       133
-------------+----------------------------------   F(14, 118)      =      9.17
       Model |  7610.72315        14  543.623082   Prob > F        =    0.0000
    Residual |  6996.74781       118   59.294473   R-squared       =    0.5210
-------------+----------------------------------   Adj R-squared   =    0.4642
       Total |   14607.471       132  110.662659   Root MSE        =    7.7003

------------------------------------------------------------------------------
  D.awe_priv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    share_lh |
         LD. |  -28.31247   17.45171    -1.62   0.107    -62.87161    6.246678
             |
    awe_priv |
         LD. |  -.6954472   .0751745    -9.25   0.000    -.8443131   -.5465812
        L2D. |  -.5477598   .0717167    -7.64   0.000    -.6897783   -.4057412
------------------------------------------------------------------------------
```

Note: Coefficients for month indicators and constant not shown to save space.

```
Akaike's information criterion and Bayesian information criterion
-----------------------------------------------------------------------------
       Model |        Obs  ll(null)  ll(model)      df         AIC        BIC
-------------+---------------------------------------------------------------
           . |        133 -501.1983  -452.2485      15    934.4969   977.8521
-----------------------------------------------------------------------------
               Note: N=Obs used in calculating BIC; see [R] BIC note.

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.512               1                   0.1130
      12     |         23.524              12                   0.0236
---------------------------------------------------------------------------
                        H0: no serial correlation

. /*Rolling window results for - Alternative Model
*Windows over 6 years not considered as there are only 12 years of data and leaving
out one year of lags plus a 6 year window leaves only 60 observations to fit.
  RWrmse72 =  8.58
  RWrmse60 =  9.24
  RWrmse48 = 10.04
  RWrmse36 = 10.57
```

4. Alternative Model with Robust Standard Errors

```
Regression with Newey-West standard errors      Number of obs     =        133
maximum lag: 12                                 F( 14,       118) =      23.49
                                                Prob > F          =     0.0000
------------------------------------------------------------------------------
             |             Newey-West
  D.awe_priv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    share_lh |
         LD. |  -28.31247   16.06228    -1.76   0.081    -60.12016    3.495226
             |
    awe_priv |
         LD. |  -.6954472   .0859604    -8.09   0.000    -.8656722   -.5252222
        L2D. |  -.5477598   .0750042    -7.30   0.000    -.6962884   -.3992311
------------------------------------------------------------------------------
```

Note: Coefficients for month indicators and constant not shown to save space.

5. Results for Forecasting March 2019

Estimated only on the last window (last 60 observations)

```
      Source |       SS           df       MS      Number of obs   =        60
-------------+----------------------------------   F(14, 45)       =      3.88
       Model |  3843.16422        14   274.51173   Prob > F        =    0.0003
    Residual |  3181.89571        45  70.7087935   R-squared       =    0.5471
-------------+----------------------------------   Adj R-squared   =    0.4062
       Total |  7025.05993        59  119.068812   Root MSE        =    8.4089

------------------------------------------------------------------------------
  D.awe_priv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    share_lh |
         LD. |  -38.43324   26.61219    -1.44   0.156    -92.03294    15.16647
             |
    awe_priv |
         LD. |  -.6407784   .1418874    -4.52   0.000    -.9265542   -.3550025
        L2D. |  -.4746529   .1275719    -3.72   0.001    -.7315959   -.2177099
             |
         md2 |   14.53186   8.573556     1.69   0.097    -2.736166    31.79989
         md3 |  -1.158425   5.805917    -0.20   0.843    -12.85214    10.53529
       _cons |   1.325165   3.898538     0.34   0.736    -6.526894    9.177224
------------------------------------------------------------------------------
```

Note: Coefficients for month indicators 4-12 not shown to save space.

Summary Statistics

Rolling Window Residuals for w=60	
Obs	84
Mean	2.22
Median	0.79
5th Percentile	-9.06
95th Percentile	19.54

Last 3 months of data

Date	awe_priv	share_lh
Dec 2018	878.60	13.79
Jan 2019	874.45	13.40
Feb 2019	878.58	13.94