ØAMET4100 · Spring 2019
Worksheet 11

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1 Time Series Regressions

Exercise 1.1 Suppose that you have quarterly data of the GDP growth rate and the term spread (i.e., the difference between long-term interest rate, the 10-year treasury bond, and a short-term interest rate, the 3-month treasury bill). You would like to forecast the GDP growth rate. You estimate different regressions in Stata, and the output is shown below after part (f).

(a) Consider a two-variable VAR model for the growth rate of GDP ($GDPGR$) and the term spread ($TSpread$) with a lag length of 2. Write down the population regression model for this VAR.

(b) Look at the VAR regression results reported in Stata for the model specified in part (a).

(i) What time period is included in this regression?

(ii) Using the VAR regression results, what is your forecast for the GDP growth rate in 2013:Q1? What is your forecast for the $TSpread$ in 2013:Q1?

(c) Look at the Stata results for the AR(1) model of $GDPGR$. Use this model and the iterated method to forecast the GDP growth rate in 2013:Q2.

(d) Look at the Stata results for the AR(2) model of $GDPGR$. Use this model and the iterated method to forecast the GDP growth rate in 2013:Q2.

(e) Look at the Stata results for the VAR(2) model with $GDPGR$ and $TSpread$. Use this model and the iterated method to forecast the GDP growth rate in 2013:Q2.

(f) Look at the Stata results for the ADL(2,2) model for $GDPGR$ and $TSpread$. Use this model and the direct method to forecast the GDP growth rate in 2013:Q2.

```
. reg GDPGR L1.GDPGR if tin(1962q1,2012q4), robust ;

Linear regression                                       Number of obs =     204
                                                        F(  1,   202) =   20.61
                                                        Prob > F      =  0.0000
                                                        R-squared     =  0.1189
                                                        Root MSE      =  3.1565

------------------------------------------------------------------------------
             |               Robust
      GDPGR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      GDPGR |
        L1. |   .3436466   .0756953     4.54   0.000     .1943922     .492901
            |
      _cons |   1.990784   .3509759     5.67   0.000     1.298737     2.68283
------------------------------------------------------------------------------

. reg GDPGR L1.GDPGR L2.GDPGR if tin(1962q1,2012q4), robust ;

Linear regression                                       Number of obs =     204
                                                        F(  2,   201) =   12.69
                                                        Prob > F      =  0.0000
                                                        R-squared     =  0.1475
                                                        Root MSE      =  3.1127

------------------------------------------------------------------------------
             |               Robust
      GDPGR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      GDPGR |
        L1. |   .2807815   .0792383     3.54   0.000     .1245365    .4370265
        L2. |   .1792251    .079602     2.25   0.025     .0222629    .3361873
            |
      _cons |   1.627606   .4036524     4.03   0.000     .8316695    2.423543
------------------------------------------------------------------------------

.  var GDPGR Tspread if tin(1981q1, 2012q4), lag(1/2) ;

Vector autoregression

Sample:  1981q1 - 2012q4                        No. of obs      =       128
Log likelihood = -380.9074                      AIC             =  6.107928
FPE            =  1.540725                      HQIC            =  6.198459
Det(Sigma_ml)  =  1.317747                      SBIC            =  6.330743

Equation           Parms      RMSE     R-sq      chi2     P>chi2
------------------------------------------------------------------
GDPGR                  5     2.42085   0.3111   57.81013   0.0000
Tspread                5     .494027   0.8309   629.0798   0.0000
------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
GDPGR        |
       GDPGR |
         L1. |   .2895533   .0819992     3.53   0.000     .1288377    .4502688
         L2. |   .2163919   .0799637     2.71   0.007      .059666    .3731179
             |
     Tspread |
         L1. |  -.9025494    .362357    -2.49   0.013    -1.612756   -.1923426
         L2. |   1.329831   .3643092     3.65   0.000     .6157977    2.043863
             |
       _cons |    .516344   .4635137     1.11   0.265    -.3921261    1.424814
-------------+----------------------------------------------------------------
Tspread      |
       GDPGR |
         L1. |   .0099785   .0167337     0.60   0.551     -.022819     .042776
         L2. |  -.0572451   .0163183    -3.51   0.000    -.0892285   -.0252618
             |
     Tspread |
         L1. |   1.058228   .0739468    14.31   0.000     .9132947    1.203161
         L2. |  -.2191902   .0743452    -2.95   0.003    -.3649042   -.0734762
             |
       _cons |    .455774   .0945901     4.82   0.000     .2703809    .6411671
------------------------------------------------------------------------------

. reg GDPGR L(2/3).GDPGR L(2/3).Tspread if tin(1981q1, 2012q4), robust ;

Linear regression                               Number of obs =     128
                                                F(  4,   123) =    9.64
                                                Prob > F      =  0.0000
                                                R-squared     =  0.1913
                                                Root MSE      =   2.623

------------------------------------------------------------------------------
             |               Robust
       GDPGR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       GDPGR |
         L2. |   .3373794   .1009694     3.34   0.001     .1375167    .5372421
         L3. |   .0282209   .1286568     0.22   0.827    -.2264473    .2828891
             |
     Tspread |
         L2. |   .6165915   .5032103     1.23   0.223    -.3794825    1.612665
         L3. |  -.0057762   .5504344    -0.01   0.992    -1.095327    1.083775
             |
       _cons |   .5684148   .6274199     0.91   0.367    -.6735243    1.810354
------------------------------------------------------------------------------

.  list qtr GDPGR Tspread if tin(2011q1, 2012q4) ;

     +-----------------------------+
     |    qtr      GDPGR    Tspread |
     |-----------------------------|
217. | 2011q1   -1.29898   3.333333 |
218. | 2011q2   3.137851   3.163333 |
219. | 2011q3   1.353836   2.403333 |
220. | 2011q4   4.751806   2.033333 |
221. | 2012q1   3.642223       1.97 |
     |-----------------------------|
222. | 2012q2     1.1972   1.736667 |
223. | 2012q3   2.747022       1.54 |
224. | 2012q4   .1452808       1.62 |
     +-----------------------------+
```

Exercise 1.2 (Stock and Watson, Review the Concepts 16.1) A macroeconomist wants to construct forecasts for the following macroeconomic variables: GDP, consumption, investment, government purchases, exports, imports, short-term interest rates, long-term interest rates, and the rate of price inflation. He has quarterly time series for each of these variables from 1970 to 2014. Should he estimate a VAR for these variables and use this for forecasting? Why or why not? Can you suggest an alternative approach?

Exercise 1.3 (Adapted from Stock and Watson, Review the Concepts 16.2) Suppose that Y_t follows a stationary AR(1) model with $\beta_0 = 0$ and $\beta_1 = 0.7$. If $Y_t = 5$, what is your forecast of Y_{t+2} (that is, what is $Y_{t+2|t}$)? What is $Y_{t+h|t}$ for $h = 30$? Does this forecast for $h = 30$ seem reasonable to you?

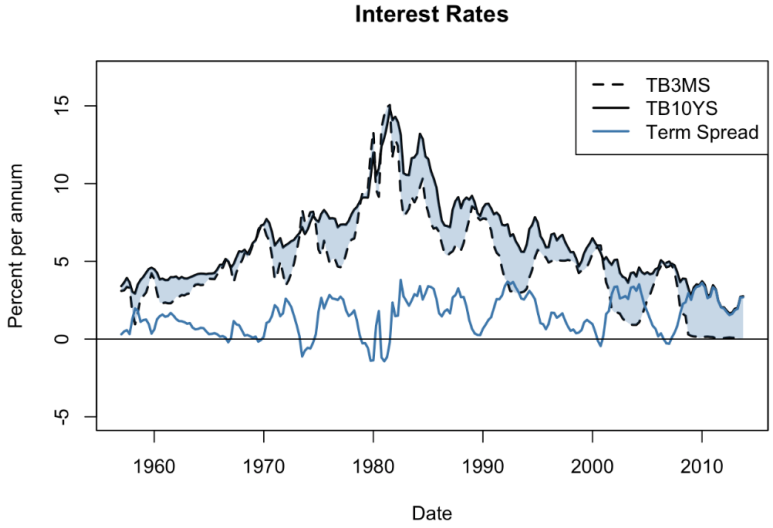
Exercise 1.4 (Stock and Watson, Review the Concepts 16.3) A version of the permanent income theory of consumption implies that the logarithm of real GDP (Y) and the logarithm of real consumption (C) are cointegrated with a cointegrating coefficient equal to 1. Explain how you would investigate this implication by:

(a) Plotting the data.

(b) Using a statistical test.

Exercise 1.5 Consider the time series of the U.S. 3-month treasury bills ($TB3M$), 10-year treasury bonds ($TB10Y$), and the term spread ($TSpread$), the difference between the long- and short-term interest rate).

(a) The $TB3M$, $TB10Y$, and the term spread are plotted over time in the figure below. Looking at this plot, would you say that $TB3M$ and $TB10Y$ appear to be conintegrated? Why or why not?



Use the Stata output, shown below after part (d), to answer the rest of the exercises.

(b) Is there statistical evidence that $TB3M$ has a unit root? Why or why not?

(c) Is there statistical evidence that $TB10Y$ has a unit troot? Why or why not?

(d) Do you find statistical evidence that $TB3M$ and $TB10Y$ are cointegrated, with cointegrating coefficient equal to 1? Why or why not?

```
. dfuller TB3M if tin(1962q1, 2012q4), lag(6) ;

Augmented Dickey-Fuller test for unit root         Number of obs   =       204

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.172           -3.475            -2.883            -2.573
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.2166

. dfuller TB10Y if tin(1962q1, 2012q4), lag(6) ;

Augmented Dickey-Fuller test for unit root         Number of obs   =       204

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.027           -3.475            -2.883            -2.573
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7434

. gen Tspread = TB10Y - TB3M ;

. dfuller Tspread if tin(1962q1, 2012q4), lag(6) ;

Augmented Dickey-Fuller test for unit root         Number of obs   =       204

                              ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.975           -3.475            -2.883            -2.573
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0015
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