Notes to Lecture 13: Example of Wu-Hausman test and residual mis-specification tests

Phillips curve example.

We estimate a price Phillips curve on Norwegian annual data. The results are:

```
EQ(1) Modelling INF by OLS (using ulike modellspesifikasjoner for Phillipskurve.in7)
 The estimation sample is: 1980 to 2005

             Coefficient  Std.Error  t-value  t-prob Part.R^2
INF_1           0.709913    0.08224     8.63   0.000   0.7720
Constant         4.04037      1.200     3.37   0.003   0.3402
ln(U)           -2.64712     0.7963    -3.32   0.003   0.3343
D80              4.28451      1.400     3.06   0.006   0.2985

sigma             1.1965  RSS             31.4956027
R^2             0.899496  F(3,22) =     65.63 [0.000]**
log-likelihood  -39.3852  DW                    2.34
no. of observations   26  no. of parameters        4
mean(INF)        4.60409  var(INF)           12.0529
```

INF is the annual rate of CPI inflation.
ln(U) is log of rate of unemployment.
D80 is a dummy for lifting of wage-freeze in 1980.

Wu-Hausman test

Estimate a marginal equation for *ln(U)*, as a function of *ln(U)_1*, which is not included in EQ(1).

```
EQ(2) Modelling ln(U) by OLS (using ulike modellspesifikasjoner for Phillipskurve.in7)
     The estimation sample is: 1980 to 2005

               Coefficient  Std.Error  t-value  t-prob Part.R^2
ln(U)_1           0.812166    0.09705     8.37   0.000   0.7448
Constant          0.237388     0.1125     2.11   0.046   0.1564

sigma             0.205012  RSS             1.00871589
R^2               0.744774  F(1,24) =     70.03 [0.000]**
log-likelihood     5.35004  DW                   0.983
no. of observations     26  no. of parameters        2
mean(ln(U))        1.11698  var(ln(U))        0.152009
```

The residuals from EQ(2) are added to EQ(1).

```
EQ(3) Modelling INF by OLS (using ulike modellspesifikasjoner for Phillipskurve.in7)
     The estimation sample is: 1980 to 2005

                Coefficient  Std.Error  t-value  t-prob Part.R^2
INF_1              0.744862     0.1079     6.91   0.000   0.6943
Constant            3.40807      1.734     1.97   0.063   0.1554
ln(U)              -2.23293      1.143    -1.95   0.064   0.1537
D80                 4.40032      1.442     3.05   0.006   0.3072
lnU_residuals     -0.930339      1.813   -0.513   0.613   0.0124
```

lnU_residuals is not statistically significant in EQ(2), so weak exogeneity is not rejected.

A small battery of residual mis-specification tests

Autocorrelation

DW in EQ(1) is not the correct test to use because of the lagged endogenous variable, the DW is biased toward 2 in ADL models. Instead we use the test that we discussed briefly in Lecture 3: Regress the EQ(1) residuals on J lags, and the set of regressors, and test significance of the J lags of the residuals.

To get an idea about the choice of J it is useful to consult the ACF (cf Lecture 3):

```
Residual correlogram (ACF) from lag 1 to 4:
    -0.17388     0.078630    -0.038826    -0.025352
```

which suggest that $J = 2$ is (more than) enough. The Error autocorrelation test for lag order 1 to 2 gives the output:

```
Error autocorrelation coefficients in auxiliary regression:
 Lag Coefficient  Std.Error
   1    -0.19079     0.2466
   2    0.042291     0.2544
RSS = 30.346  sigma = 1.5173

Testing for error autocorrelation from lags 1 to 2
Chi^2(2) =  0.94901 [0.6222]   and F-form F(2,20)  =  0.37883 [0.6895]
```

The auxiliary regression (autoregressive part) comes first, and the χ^2 and F distributed tests of the joint H_0 of both lag coefficients being zero. Since the second lag coefficient is so small, a more powerful test is to test the H_0 of first order autocorrelation. This gives:

```
Error autocorrelation coefficients in auxiliary regression:
  Lag Coefficient  Std.Error
   1    -0.20226     0.2312
RSS = 30.3879  sigma = 1.44704

Testing for error autocorrelation from lags 1 to 1
Chi^2(1) =  0.91440 [0.3389]   and F-form F(1,21)  =  0.76547 [0.3915]
```

Heteroscedastisity

White's test (Lecture 13): Regress squared residuals form EQ(1) on the set of regressors *and* their squares.

```
Heteroscedasticity coefficients:
             Coefficient    Std.Error      t-value
INF_1           -0.22583      0.57075     -0.39567
ln(U)            -8.8664       8.5753      -1.0339
INF_1^2         0.021762     0.041116      0.52929
ln(U)^2           3.3874       3.7572      0.90155
D80^2            -4.0020       3.5572      -1.1251

RSS = 97.1579  sigma = 2.46422  effective no. of parameters = 6
Regression in deviation from mean

Testing for heteroscedasticity using squares
 Chi^2(5) =   4.0924 [0.5362]   and F-form F(5,16)  =  0.59777 [0.7023]
```

The χ^2 and F distributed lag version of White's tests are reported at the bottom of this screen-capture. If enough data, can also include cross products of regressors in auxiliary regression (cf Lecture 3).

Stability

Chow test (see Lecture 2) can be estimated recursively, e g the whole sequence of 1-step predictive Chow-tests, along with recursive estimation of the parameters of the model.

In the graph below, panel a)-d) shows the sequence of regression coefficient estimates (βs), panel e) gives the recursively estimated standard deviation (σ), and panel f) gives the 1-step predictive Chow tests.