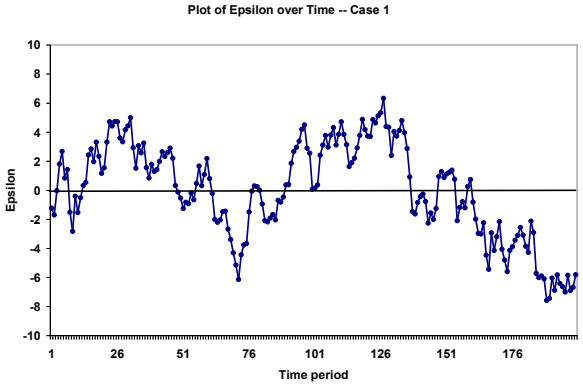
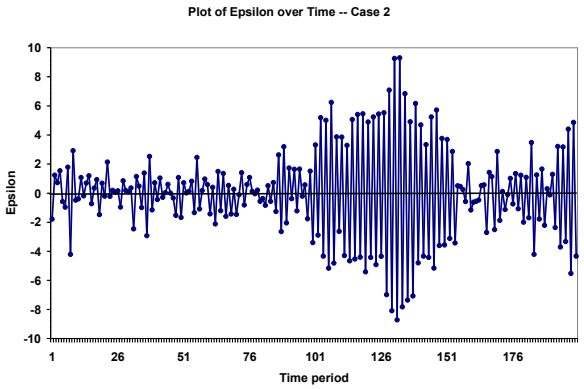
Time series data: Part 2

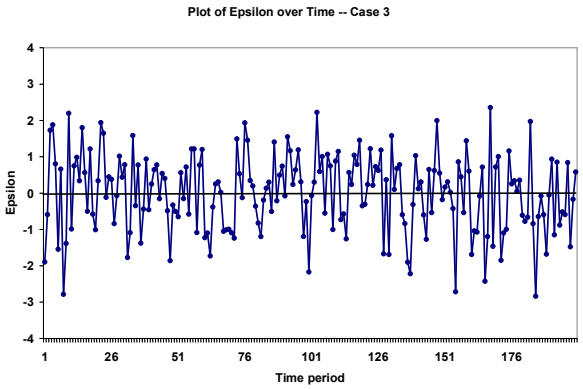
1



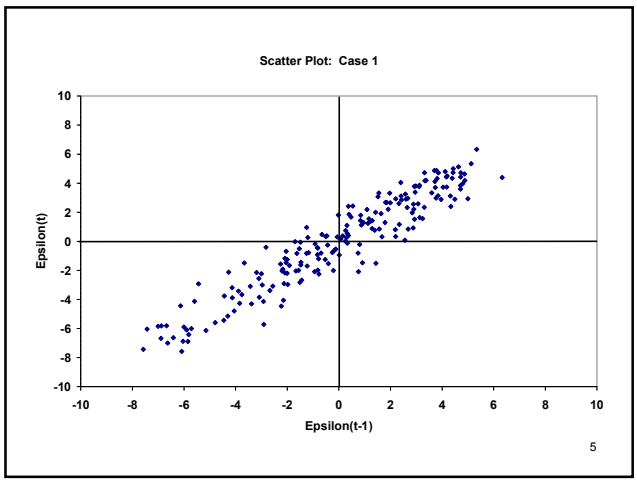
2



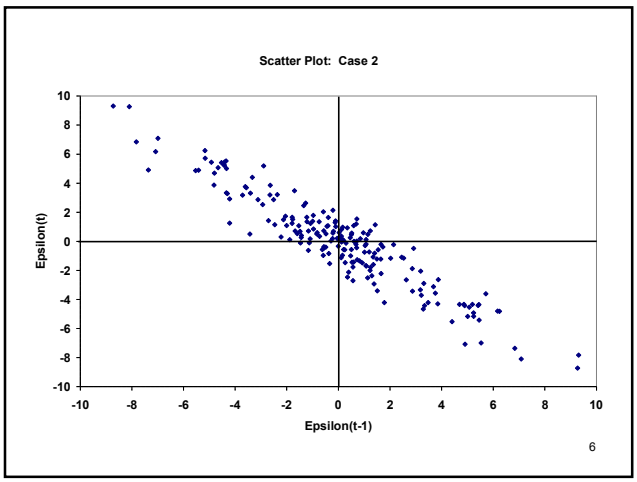
3



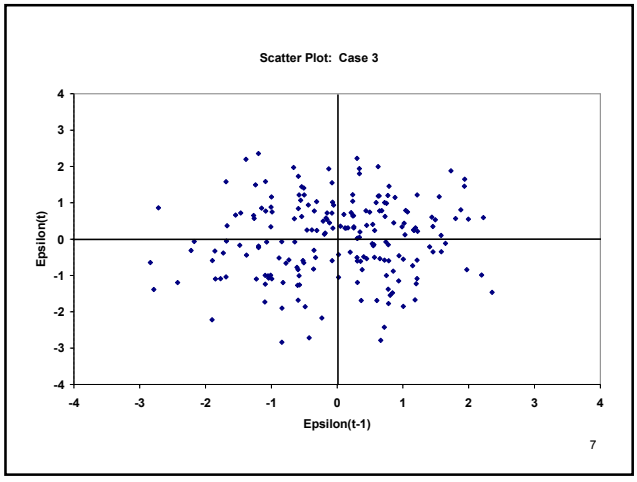
4



5



6



7

DW Statistic

- For 0<ρ<1
- H_o: ρ=0
- H_a: ρ>0

$$\hat{d} < d_l \text{ reject null}$$

$$d_l \le \hat{d} < d_u \text{ uncertain}$$

$$\hat{d} \ge d_u \text{ cannot reject null}$$

8

Table A-2
Models with an intercept (from Savin and White)

Durbin-Watson Statistic: 5 Per Cent Significance Points of dL and dU

	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
n	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.796	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.079	1.891	1.015	1.978	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.876	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.197
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.029	2.017	0.970	2.098	0.912	2.180
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.952	2.149
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.022	1.038	2.088
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.959	1.170	2.010
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984
65	1.567	1.629	1.536	1.662	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.885	1.301	1.928	1.266	1.964
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.838	1.369	1.874	1.337	1.910	1.305	1.948
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925

9

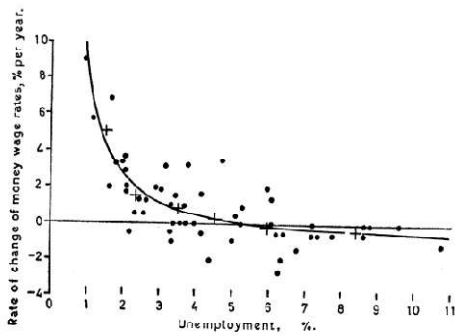
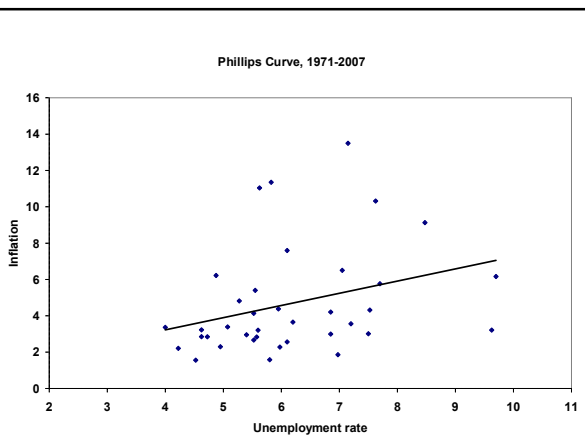


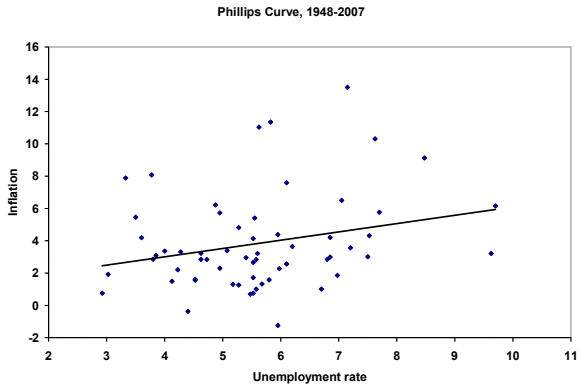
Fig.1. 1861 – 1913

10

11



12



13

```
. * The order of the time series
. * data must be specified by an
. * index.  Here, we use year as the
. * index
. tsset year
        time variable:  year, 1947 to 2007
                delta:  1 unit
```

14

```
. * run classical phillips curve
.
. reg inflation unemp

      Source |       SS       df       MS              Number of obs =      60
-------------+------------------------------           F(  1,    58) =    4.06
       Model |  33.5634573     1  33.5634573            Prob > F      =  0.0486
    Residual |  479.480783    58  8.26691005            R-squared     =  0.0654
-------------+------------------------------           Adj R-squared =  0.0493
       Total |   513.04424    59  8.69566509            Root MSE      =  2.8752

------------------------------------------------------------------------------
   inflation |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       unemp |   .5138821   .2550362     2.01   0.049      .0033718    1.024392
       _cons |   .9519491   1.474108     0.65   0.521     -1.998798    3.902696
------------------------------------------------------------------------------

.
. * get durbin watson statistic
. estat dwatson

Durbin-Watson d-statistic(  2,    60) =  .8076584
```

15

Table A-2
Models with an intercept (from Savin and White)

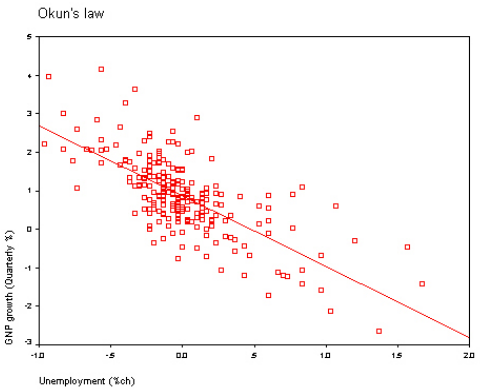
Durbin-Watson Statistic: 5 Per Cent Significance Points of dL and dU

	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
n	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.796	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.079	1.891	1.015	1.978	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.876	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.197
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.029	2.017	0.970	2.098	0.913	2.180
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.952	2.149
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.022	1.038	2.088
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.958	1.170	2.010
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984
65	1.567	1.629	1.536	1.662	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.882	1.301	1.923	1.266	1.964
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.838	1.369	1.874	1.337	1.910	1.305	1.948
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925

16

```
. * output residual
. predict resid_a, residual
(1 missing value generated)

.
. * lag the variable 1 period
. gen resid_a1=resid_a[_n-1]
(2 missing values generated)

.
. * estimate ar(1) term
. reg resid_a resid_a1, noconst

      Source |       SS       df       MS              Number of obs =      59
-------------+------------------------------           F(  1,    58) =   30.13
       Model |  154.739524     1  154.739524            Prob > F      =  0.0000
    Residual |  297.909892    58  5.13637744            R-squared     =  0.3419
-------------+------------------------------           Adj R-squared =  0.3305
       Total |  452.649415    59  7.67202399            Root MSE      =  2.2664

------------------------------------------------------------------------------
     resid_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    resid_a1 |    .568224   .1035255     5.49   0.000     .3609952    .7754529
------------------------------------------------------------------------------
```

17



18

```
. *now estimate augmented Phillips Curve
. * construct difference in inflation
. gen inflation_1=inflation[_n-1]
(1 missing value generated)

. gen d_inf=inflation-inflation_1
(1 missing value generated)

.
. reg d_inf unemp

      Source |       SS       df       MS              Number of obs =      60
-------------+------------------------------           F(  1,    58) =    3.76
       Model |   21.645692     1   21.645692            Prob > F      =  0.0573
    Residual |  333.612884    58  5.75194628            R-squared     =  0.0609
-------------+------------------------------           Adj R-squared =  0.0447
       Total |  355.258576    59   6.0213318            Root MSE      =  2.3983

------------------------------------------------------------------------------
       d_inf |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       unemp |  -.4126824   .2127343    -1.94   0.057    -.8385164    .0131517
       _cons |   2.116596   1.229603     1.72   0.091    -.3447227    4.577914
------------------------------------------------------------------------------

. estat dwatson

Durbin-Watson d-statistic(  2,    60) =  1.546911
```

Lag inflation

1st Difference in inflation

19

Identified time series ar(k) correction procedure

Corcran-Orcutt procedure

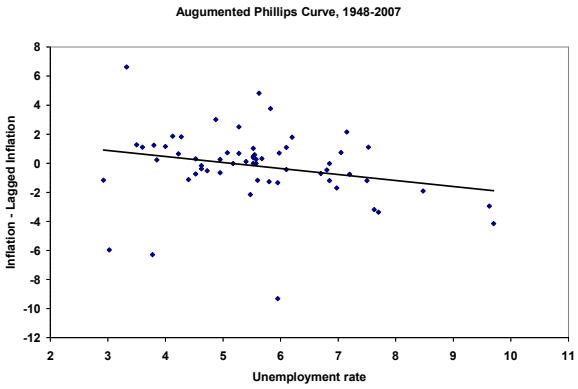
```
prais d_inf unemp, corc twostep
```

Same model statement
As before

20

```
. prais d_inf unemp, corc twostep

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.1559

Cochrane-Orcutt AR(1) regression -- twostep estimates

      Source |       SS       df       MS              Number of obs =      59
-------------+------------------------------           F(  1,    57) =    7.13
       Model |   34.338162     1   34.338162           Prob > F      =  0.0099
    Residual |  274.681638    57   4.8189761           R-squared     =  0.1111
-------------+------------------------------           Adj R-squared =  0.0955
       Total |    309.0198    58  5.32792758           Root MSE      =  2.1952

------------------------------------------------------------------------------
       d_inf |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       unemp |  -.5934445   .2223151    -2.67   0.010    -1.038623   -.1482662
       _cons |   3.269425   1.296032     2.52   0.014     .6741659    5.864685
-------------+----------------------------------------------------------------
         rho |   .1559494
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    1.546911
Durbin-Watson statistic (transformed) 1.978150
```

Adjusting for ar(1) changes Results some



Taylor Rule

$$i_t = \pi_t + r_t + a_n(\pi_t - \pi_t^*) + a_y(y_t - \hat{y}_t)$$

$$i_t = r_t - a_n\pi_t^* + (1 + a_n)\pi_t + a_y(y_t - \hat{y}_t)$$

let $\pi_t^* = 2$ *percent*

$r_t = 2$ *percent*

Taylor suggests $a_n = a_y = 0.5$

$$i_t = 1 + 1.5\pi_t + 0.5(y_t - \hat{y}_t)$$

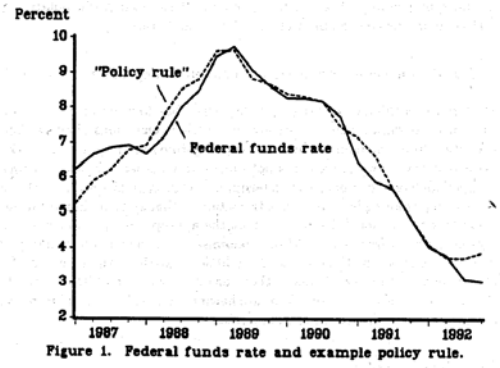


Figure 1. Federal funds rate and example policy rule.

```
* index the data for time series use
tsset index

*generate ln(gdp)
gen gdprl=ln(gdp_r)
label var gdprl "ln of real dgp"

*get lag of fed fund rate
* will use later
gen ffr1=ffr[_n-1]
label var ffr1 "lag of fed fund rate"

*get lag of gdprl
* will use later
gen gdprl1=gdprl[_n-1]
label var gdprl1 "lag of gdprl"
```



```
* generate 1 year inflation
* by taking difference between current
* and a 4 period lag
* report in percent
gen gdp_def4=gdp_def[_n-4]
gen inflation=100*(ln(gdp_def)-
ln(gdp_def4))
label var inflation "one-year inflation
rate in percent"
* reduce the data to the post-Greenspan
years
keep if year>=1987
```



```
. * run a regression of gdprl on a trend
. reg gdprl index

      Source |       SS       df       MS              Number of obs =      86
-------------+------------------------------           F(  1,    84) =10808.47
       Model |  2.91287537     1  2.91287537           Prob > F      =  0.0000
    Residual |  .022637942    84  .000269499           R-squared     =  0.9923
-------------+------------------------------           Adj R-squared =  0.9922
       Total |  2.93551331    85  .034535451           Root MSE      =  .01642

------------------------------------------------------------------------------
       gdprl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       index |   .0074137   .0000713   103.96   0.000     .0072719    .0075555
       _cons |   8.253915   .0081458  1013.28   0.000     8.237716    8.270113
------------------------------------------------------------------------------

* output residuals (output gap)
predict gdprl_res, residuals

.
* scale gap in percent by
* multiplying by 100
gen gap=100*gdprl_res
```



```
. * run taylor rule regression
. reg ffr inflation gap

      Source |       SS       df       MS              Number of obs =      86
-------------+------------------------------           F(  2,    83) =   19.78
       Model |  125.327921     2  62.6639604           Prob > F      =  0.0000
    Residual |  262.987021    83  3.16851832           R-squared     =  0.3227
-------------+------------------------------           Adj R-squared =  0.3064
       Total |  388.314942    85  4.56841108           Root MSE      =    1.78

------------------------------------------------------------------------------
         ffr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   inflation |   1.120342   .2535686     4.42   0.000     .6160043    1.62468
         gap |   .5149623   .1183526     4.35   0.000     .2795636    .7503609
       _cons |    2.06164   .6535725     3.15   0.002     .7617106    3.361569
------------------------------------------------------------------------------

. estat dwatson

Durbin-Watson d-statistic(  3,    86) =  .0693391
```

```
. estat dwatson

Durbin-Watson d-statistic(  3,    86) =  .0693391
```

```
. * test the taylor rule parameters using
. * an f-test
. test (gap=0.5) (inflation=1.5)(_cons=1.0)

 ( 1)  gap = .5
 ( 2)  inflation = 1.5
 ( 3)  _cons = 1

       F(  3,    83) =    0.89
            Prob > F =    0.4480
```


Table A-2
Models with an intercept (from Savin and White)

Durbin-Watson Statistic: 5 Per Cent Significance Points of dL and dU

	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
n	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.796	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.079	1.891	1.015	1.978	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.876	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.197
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.028	2.017	0.970	2.098	0.912	2.180
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.952	2.149
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.022	1.038	2.088
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.959	1.170	2.010
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984
65	1.567	1.630	1.536	1.663	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.883	1.301	1.923	1.266	1.964
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.838	1.369	1.874	1.337	1.910	1.305	1.948
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925


```
. prais ffr inflation gap, corc twostep

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.9643

Cochrane-Orcutt AR(1) regression -- twostep estimates

      Source |       SS       df       MS              Number of obs =      85
-------------+------------------------------           F(  2,    82) =   11.23
       Model |  4.47345645     2  2.23672822           Prob > F      =  0.0000
    Residual |  16.3318273    82  .199168626           R-squared     =  0.2150
-------------+------------------------------           Adj R-squared =  0.1959
       Total |  20.8052838    84   .24768195           Root MSE      =  .44628

------------------------------------------------------------------------------
         ffr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   inflation |   .7559721   .2229863     3.39   0.001     .3123813    1.199563
         gap |   .3110593   .0930983     3.34   0.001     .1258571    .4962616
       _cons |   1.878748   1.450736     1.30   0.199    -1.007228    4.764725
-------------+----------------------------------------------------------------
         rho |   .9642664
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.069339
Durbin-Watson statistic (transformed) 0.926851

.
```