CCR: A User Guide

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This is a user guide for the CCR package written in GAUSS by the author. Financial support by NSF SES-9213930 is gratefully acknowledged.

1. Introduction

This is a user guide for the CCR package written in GAUSS. This package contains programs to implement Park's (1992) Canonical Cointegrating Regression (CCR) and CCR related tests described in the companion paper, Ogaki (1993a). This paper uses Ogaki's (1993a) notation. See Ogaki (1992) and Ogaki and Park (1993) for examples of applications.

The minimum knowledge of GAUSS that is necessary to run these programs can be obtained in Ogaki (1993b, Section 2).

2. Programs

Each file with *.SET extension defines a GAUSS procedure. Each of these files come with an example file with a *.EXP extension that contains instructions about how to use the program.

2.A. CCR.SET

This program defines a procedure to implement Park's (1992) CCR. Park's (1990) H(p,q) tests for the null of stochastic cointegration and deterministic cointegration restriction. The example file for this program, CCR.EXP, is printed as Appendix A and the output file COINT.OUT is printed as Appendix B.

As explained in Ogaki (1993b), it is recommended that the third stage CCR estimates and H(p,q) test results from the fourth stage CCR are reported.

Suppose that $y(t)$ and $X_2(t)$ are first difference stationary random variable and random variables with unknown drift.

First, let us consider the case where $y(t)$ and $X_2(t)$ are stochastically cointegrated with the deterministic cointegration restriction, then a cointegrating regression

(1) $y(t) = \theta + X_2(t)'\gamma + u(t)$

is used to estimate a normalized cointegrating vector γ.

For (1), the global variable *x1p* in the CCR.EXP file should be defined by a statement

x1p=ones(tend,1);

as in the example file. In this case, the deterministic cointegration restriction can be tested by setting

dctflag=1|1;

which will produce Park's H(0,1) test for the null of the deterministic cointegration restriction. For H(1,q) tests of stochastic cointegration,

sctflag=2|2|5|1|0;

will produce H(1,2),...,H(1,5) tests.

Second, let us consider the case where $y(t)$ and $X_2(t)$ are stochastically cointegrated without the deterministic cointegration restriction, then a cointegrating regression

(2) $y(t) = \theta + \mu t + X_2(t)'\gamma + u(t)$

is used. In this case,

x1p=ones(tend,1)~seqa(1,1,tend);

should be used to define *x1p*. Because the deterministic cointegration restriction is not satisfied,

dctflag=0|0;

is used, but *sctflag* is same as in the first case to construct H(1,q) tests for stochastic cointegration.

In some applications, it is appropriate to assume that drift terms of *y(t)* and $X_2(t)$ are known to be zero if these variables do not exhibit a tendency to drift upward. In this case, there is no deterministic cointegration restriction, so set dctflag=0|0. For tests of stochastic cointegration, H(0,q) tests should be used. So set sctflag=1|1|4|1|0, for example.

In the CCR.EXP file, variables *rm* and *rv* are set up to construct a Wald test. When you do not have restrictions to test, set *rm*=0. When an error message such as "matrices not conformable" is encountered, make sure that the *rm* variable is defined conformably with the particular application.

2.B. JPQTSTUR.SET

This program defines a procedure for for Park's (1990) J(p,q) test for the null of a unit root that was originally developed by Park and Choi (1988). Critical values for J(p,q) tests are reported in Park and Choi (1988) and Ogaki (1993). Note that the null hypothesis is rejected when the J(p,q) statistic is smaller than the critical value.

2.C. GPQTST.SET

This program defines a procedure for Park's (1990) G(p,q) test for the null of trend stationarity that was originally developed by Park and Choi (1988). The G(p,q) test statistics have asymptotic chi square distributions, and this program prints p-values in the output file.

2.D. IPQTST.SET

This program defines a procedure for Park's (1990) I(p,q) test for the null of no cointegration that was originally developed by Park, Ouliaris, and Choi (1988). Asymptotic distributions of I(p,q) tests are based on a

OLS cointegrating regression rather than CCR. Hence this program uses OLS. Critical values for I(p,q) tests are reported in Park and Choi (1988) and Ogaki (1993). Note that the null hypothesis of no cointegration is rejected when the I(p,q) statistic is smaller than the critical value and that the distributions of I(p,q) depend on the number of regressors.

References

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APPENDIX A   CCR.EXP FILE

```
@ CCR.EXP @

@-----------------------------------------------------------------------------
Written by Masao Ogaki

Last Revision:  11/03/92
-----------------------------------------------------------------------------@
/*
This is an example file for CCR.SET written in Version 2 of GAUSS

This program has been used and seem to be free of errors. However, I do
not assume responsibility for any remaining errors.

   @@ To run this example file, type
       RUN CCR.SET [F4][F2]
       RUN CCR.EXP [F4][F2]
      The program CCR.SET defines a procedure for CCR.

   @@ The user is supposed to go through Step 1-3 to modify this file for
      the user's problem.  All the parameters for the procedures in CCR.SET
      controlled by parameters defined in this file, so that the
      user does not have to modify the CCR.SET file.

Model:  x2(t) (k by 1 vector) is difference stationary:
        x2(t)=d+x2(t-1)+v(t)
        y(t)=x(t)'b+u(t)

    where x(t)=[x1(t)' x2(t)']'
    x1(t) is a vector of deterministic terms: typically, a constant
        or a constant and a linear time trend.
    Let w(t)=[u(t),v(t)']'.  We assume w(t) is stationary with zero
        mean and the long run covariance matrix omega.

*/
@ ======================= User Definition Area ========================== @
@ ******************************************************************** @
@ ----------- Step 1: Prepare the Output File ---------------------------@
@ ******************************************************************** @
output file=coint.out reset; @ Specify the name of the output file. @

    @ Prepare the following message which will be printed
      at the top of the output file @

? "CCR.OUT   Ogaki and Park, Durables & Nondurable+Services, Total Pop";
datestr(0);
timestr(0);

@ ************************************************************** @
@ --------------- Step 2: Prepare the Data -------------------- @
@ ************************************************************** @
@ 1. Reading in data @
load qn[176,2]=qnrnd91.dat;      @nondurables (nominal~real)@
load qd[176,2]=qnrd91.dat;       @durables (nominal~real)@
load mpopl[529,2]=mpop91.dat;        @population (total~16+)@

@ 2. Specify the sample period @
 nob=169;  @the number of observation in the data@
 taubeg=2;                  @ The beginning of the sample period @
```

```
  tauend=nob;                   @ The end of the sample period @
  tend=tauend-taubeg+1;         @ The sample size @

 @ 3. Transform the data if necessary @

 mpopl=mpopl/1000000;
 mpopl=mpopl[.,1]-0.5*(mpopl[.,1]-mpopl[.,2]);   @mpopl[.,2]; 16+@
 popul=reshape(mpopl[1:nob*3],nob,3);
 popul=meanc(popul');  @ave. over each quarter@

 c1v=qn;
 c2v=qd;

 c1=c1v[1:nob,2]./popul[1:nob,1];  @real per capita consumption@
 c2=c2v[1:nob,2]./popul[1:nob,1];

 q2=(c2v[1:nob,1]./c2v[1:nob,2])./(c1v[1:nob,1]./c1v[1:nob,2]);

 @ 4. Define global variables x1p, x2p, yv, vp used by CCR.SET @
  @ x1p=|x1(1)'    |
        | ...      |      tend by m1 matrix
        |x1(tend)'|

    x2p=|x2(1)'    |
        | ...      |      tend by m2 matrix
        |x2(tend)'|

    yv=|y(1)    |
       | ...    |      tend by 1 vector
       |y(tend)|

    vp=|v(1)'    |
       | ...     |      tend by m2 matrix
       |v(tend)'|            @

  yv=ln(c1);
  x2p=ln(q2)~ln(c2);
  x1p=ones(tend,1);

 yv=yv[taubeg:tauend,.];
 deltx=x2p[taubeg:tauend,.]-x2p[taubeg-1:tauend-1,.];
 x2p=x2p[taubeg:tauend,.];
 vp=deltx-meanc(deltx)';

 clear q2,c1,c2,deltx;

@ ********************************************************************* @
@------- Step 3:  Specify Variable to Control the CCR procedure ------- @
@ ********************************************************************* @

st=0;     @
          This scalar controls the bandwidth parameter for the QS kernel.
          if st=0, then an automatic bandwidth estimator is used.
          if st/=0, then st is used as the bandwidth parameter.
     st=0 is recommended.@
wav=ones(cols(x2p)+1,1);  @
      This (m2+1) by 1 vector sets weights given to the a-th element of
      w(t) for the automatic bandwidth estimator (if st=0).@

bst=sqrt(tend);  @ This scalar bounds the bandwidth parameter @
```

```
maxd=0.99;    @
              if maxd=0, then nonprewhitened HAC with the QS kernel is used.
          if 0<maxd, then the elements of DeltaLS with the absolute
                value greater than maxd is replaced by maxd.  See Andrews
                and Monahan's (1990) footnote 4.@
lpn=1e+10;  @ The bounding by bst and maxd are necessary for H(p,q) tests
        but not recommended for cointegrating vector parameter estimates.
           This scalar lpn is used for 1st and 2nd stage CCR for which
           the bounding by bst and maxd is not necessary.@

dctflag=1|1;
  @ 2 by 1 vector to control the K test for deterministic
                 cointegrating restriction using sdc(t);

          dctflag[1,1]: the smallest order of time polynomial to test
                        for deterministic cointegrating restriction.
              dctflag[2,1]: the largest order of time polynomial to test
                        for deterministic cointegrating restriction.
          No test for sdc(t) will be given if dctflag[2,1]=0. @

sctflag=2|2|5|1|0;
 @ 5 by 1 vector to control H(p,q) tests for stochastic cointegrating
                 restriction using deterministic trends, sl(t):

              sctlflag[1,1]: the smallest order of time polynomial in sl(t)

               *** p=sctlflag[1,1]-1 ***

              sctfllag[2:4,1] controls the largest order of time polynomial
                        in sl(t); The largest order of polynomial in sl(t)
                        will be increased from sctlflag[2,1] to
                        sctlflag[3,1] with an increment of sctlflag[4,1].

              *** q=sctlflag[2,1] for the first result ***
                        *** q=sctlflag[2,1]+sctlflag[4,1] for the secod
                             and so on until
                        *** q=sctlflag[3,1] for the last result.

        sctlflag[5,1] controls joint tests for coefficients of sdc(t)
                      and sl(t): If sctlflag[5,1]=1, then the joint test
                      will be given; if sctlflag[5,1]=0, then no joint test
                      will be given.
             No test for sl(t) will be given if sctlflag[3,1]=0.   @

pflag=0;
 @    scalar;  Trend coefficients and their standard errors are
       are printed if pflag=1 not if pflag=0.  @

@ ** The following two arguments are
 for testing a linear restriction Rb=r. ** @

rm=zeros(2,1)~eye(2);
 @rm=R  q by cols(b) matrix for the test. If rm=0, no test for Rb=r. @

rv=1|(-1);
 @ rv=r  q by 1 vector for the test. @


@ ****************************************************************************** @
```

```
@ THE PROGRAM STARTS @
@ You need not change the following @

@ ** Initial OLS to get w(t) and bini ** @
x=x1p~x2p;
biniols=invpd(x'x)*(x'yv);
? "unmodified OLS=" biniols';
clear x;
? "****** 2nd stage CCR *****";
  bini=biniols;
  bc=ccr(bini,st,wav,lpn,lpn,zeros(2,1),zeros(5,1),pflag,0,0);
? "
***** 3rd stage CCR *****";
  bc3=ccr(bc,st,wav,lpn,lpn,zeros(2,1),zeros(5,1),pflag,rm,rv);
 load covbc3=covbc;
      @ It is recommended that estimates (bc3) from this stage
              be reported.@
? "
***** 4th stage CCR *****";
  bc4=ccr(bc3,st,wav,maxd,bst,dctflag,sctflag,pflag,rm,rv);
      @ It is recommended that H(p,q) tests from this stage be reported.@
output off;
@ ------------------------ END OF PROGRAM -------------------------------- @
```

APPENDIX B CCR.EXP OUTPUT

```
CCR.OUT   Ogaki and Park, Durables & Nondurable+Services, Total Pop
 4/15/93
10:06:13
unmodified OLS=        5.4442809        0.19171496        0.38986091
****** 2nd stage CCR *****

********** Canonical Cointegrating Regression Results (CCR.SET) *******
Prewhitened HAC with the QS kernel is used for calculation of omega
ALS and DELTALS for prewhitening=
      0.87074860       -0.17135215      0.0089588866
    0.0084930075        0.13951200      -0.047680985
      0.21577158        0.51462680      -0.071074034
    -0.027965812     8.3813910e-19     7.3484873e-18
   3.7892866e-17        0.56346646    -1.1186364e-16
   1.8490729e-18     8.4236791e-17        0.89868084
maxd=   1.0000000e+10
***** Automatic Bandwidth Estimator is used
The bandwidth parameter used       0.58271933
 ============ CCR Results ==============
Regression coefficients of x1(t)',x2(t)'=
       4.9742344        0.39004047        0.45359104
s.e.=
      0.28742374        0.12310213       0.039294020

***** 3rd stage CCR *****

********** Canonical Cointegrating Regression Results (CCR.SET) *******
Prewhitened HAC with the QS kernel is used for calculation of omega
ALS and DELTALS for prewhitening=
      0.83482377       -0.22911616       0.010042766
     0.037592386        0.13744508      -0.039774825
      0.21982532        0.51234538      -0.058636890
    -0.023468746    -2.8222503e-17    -4.0520372e-17
  -1.6967764e-17       -0.57075711     1.5999830e-17
  -1.3602820e-18     7.8048263e-17        0.87141090
maxd=   1.0000000e+10
***** Automatic Bandwidth Estimator is used
The bandwidth parameter used       0.72395561
 ============ CCR Results ==============
Regression coefficients of x1(t)',x2(t)'=
       4.7866935        0.47001508        0.47899656
s.e.=
      0.28829027        0.12195019       0.039335076
 *** Testing R*b=r ***
R=
       0.0000000         1.0000000         0.0000000
       0.0000000         0.0000000         1.0000000
r=
       1.0000000
      -1.0000000
Chi-squre value and d.f.       9892.0783        2.0000000
p-value=     0.0000000

***** 4th stage CCR *****

********** Canonical Cointegrating Regression Results (CCR.SET) *******
Prewhitened HAC with the QS kernel is used for calculation of omega
ALS and DELTALS for prewhitening=
```

```
      0.82988980      -0.25297591      0.012064291
     0.044665412       0.13685305     -0.037021275
      0.20700895       0.51271665     -0.057560714
    -0.020990302   -2.5502299e-16   -4.5114814e-17
  -6.0884728e-17      -0.57161591    5.3552917e-17
  -1.8122693e-17    2.4031182e-16       0.86994985
maxd=      0.99000000
***** Automatic Bandwidth Estimator is used
The bandwidth parameter used      0.76348065
 ============ CCR Results =============
Regression coefficients of x1(t)',x2(t)'=
       4.7841201       0.47358957       0.47928146
s.e.=
      0.30908143       0.13044862      0.042142671
 *** Testing R*b=r ***
R=
       0.0000000        1.0000000        0.0000000
       0.0000000        0.0000000        1.0000000
r=
       1.0000000
      -1.0000000
Chi-squre value and d.f.       9881.6917        2.0000000
p-value=       0.0000000
 ====== Testing for Deterministic Cointegrating Restriction ======
Regession with superfluous deterministic trends sdc(t) added
smallest order of polynomial in added time trends to be tested=
       1.0000000
largest order of plynonial in added time trends to be tested=
       1.0000000
----- Regression results with superfluous deterministic trends ----
 -- Testing if all the coefficients of sdc(t) are 0
Chi-square value and d.f.=       4.1137073        1.0000000
                  p-value=     0.042537020
 === Testing for Stochastic Cointegrating Restriction with H(p,q) ===
smallest order of polynomial in added time trends to be tested=
       2.0000000
largest order of plynonial in added time trends to be tested=
       5.0000000
 ------ Regression results with superfluous sdc(t) and s1(t) -----
--Testing if all the coefficients of s1(t) are 0
H(p,q) chi-square value and d.f.=    0.0013616757        1.0000000
                  p-value=      0.97056403
p,q=       1.0000000        2.0000000
 ------ Regression results with superfluous sdc(t) and s1(t) -----
--Testing if all the coefficients of s1(t) are 0
H(p,q) chi-square value and d.f.=       13.095311        2.0000000
                  p-value=    0.0014334725
p,q=       1.0000000        3.0000000
 ------ Regression results with superfluous sdc(t) and s1(t) -----
--Testing if all the coefficients of s1(t) are 0
H(p,q) chi-square value and d.f.=       13.359417        3.0000000
                  p-value=    0.0039204344
p,q=       1.0000000        4.0000000
 ------ Regression results with superfluous sdc(t) and s1(t) -----
--Testing if all the coefficients of s1(t) are 0
H(p,q) chi-square value and d.f.=       15.639593        4.0000000
                  p-value=    0.0035429422
p,q=       1.0000000        5.0000000
```