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===== Sub-procedures for ARDL unit root test =====
' ===== ARDL unit root test for intercept model =====

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if %selfspec = "A" then
' Determine the optimal lag length of ARDL model.
if !maxlag = 0 then
    smpl %firstperiod %lastperiod
    equation eq_y.ls dy y(-1) x1(-1) c
    table_aic_y(2,2) = eq_y.@aic
else
' If maximum lag length more than 0, then determine the optimal model using algorithm below.
if !maxlag > 0 then
    smpl %firstperiod %lastperiod
    equation eq_y.ls dy y(-1) x1(-1) c ' Calculate aic for ARDL(0,0) model.
    table_aic_y(2,2) = eq_y.@aic
    opt_aic_y = eq_y.@aic
    !opt_p = 0 ' Optimal lag length for dy.
    !opt_q = 0 ' Optimal lag length for dx.

    for !q=1 to !maxlag ' Calculate the aic for 0 lag length for dy.
    smpl %firstperiod %lastperiod
    equation eq_y.ls dy y(-1) x1(-1) dx1(-1 to -!q) c
    table_aic_y(2,2+!q) = eq_y.@aic
    if table_aic_y(2,2+!q) < opt_aic_y then
        opt_aic_y = eq_y.@aic
        !opt_p = 0
        !opt_q = !q
    endif
    endif
next

    for !p=1 to !maxlag ' Calculate the aic for 0 lag length for dx.
    smpl %firstperiod %lastperiod
    equation eq_y.ls dy y(-1) x1(-1) dy(-1 to -!p) c
    table_aic_y(2+!p,2) = eq_y.@aic
    if table_aic_y(2+!p, 2) < opt_aic_y then
        opt_aic_y = eq_y.@aic
        !opt_p = !p
        !opt_q = 0
    endif
    endif
next

    for !p=1 to !maxlag ' Calculate the aic for ARDL(m,n) model.
    for !q=1 to !maxlag
    smpl %firstperiod %lastperiod
    equation eq_y.ls dy y(-1) x1(-1) dy(-1 to -!p) dx1(-1 to -!q) c
    table_aic_y(2+!p, 2+!q) = eq_y.@aic
    if table_aic_y(2+!p,2+!q) < opt_aic_y then
        opt_aic_y = eq_y.@aic
        !opt_p = !p
        !opt_q = !q
    endif
    endif
    next
    next
endif
endif

else
if %selfspec = "M" then
    !opt_p = !fix_p
    !opt_q = !fix_q
endif
endif

' Determine the longest lag length of the optimal model.
if !opt_p >= !opt_q then
    !opt_lag = !opt_p
else

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if !lopt_p <= lopt_q then
lopt_lag = lopt_q
endif

table(1,1) check_opt_ardl ' Check the optimal lag length for the ARDL.
setcell(check_opt_ardl, 1, 1, "ARDL(" + @str(lopt_p) + ", " + @str(lopt_q) + ")")

if !lopt_p = 0 and !lopt_q = 0 then
%cond_y = "00"
else
if !lopt_p = 0 and !lopt_q <> 0 then
%cond_y = "01"
else
if !lopt_p <> 0 and !lopt_q = 0 then
%cond_y = "10"
else
if !lopt_p <> 0 and !lopt_q <> 0 then
%cond_y = "11"
endif
endif
endif
endif

if %cond_y = "00" then
smpl %firstperiod %lastperiod
equation eq_opt_y.ls dy y(-1) x1(-1) c
scalar tstat_y = eq_opt_y.@tstat(1) ' Obtain the testing t statistic.
freeze(mode=overwrite, fstat_x_table) eq_opt_y.wald c(2)=0
scalar fstat_y = @val(fstat_x_table(7,2)) ' Obtain the testing F statistic.

' ===== Bootstrap start here =====
smpl %firstperiod %lastperiod
' Estimate equation with restriction of null y(-1) for t test and x(-1) for F test.
equation restricted_t_y.ls dy x1(-1) c ' Impose y(-1) = 0.
equation restricted_f_y.ls dy y(-1) c ' Impose x(-1) = 0.

restricted_t_y.makesresids resids_t_y
restricted_f_y.makesresids resids_f_y

' Recenter residuals
scalar sum_resids_t_y = @csum(resids_t_y)
scalar sum_resids_f_y = @csum(resids_f_y)

scalar nobs_t = resids_t_y.@obs
scalar nobs_f = resids_f_y.@obs

for !c=@dtoo(%firstperiod) to @dtoo(%lastperiod)
resids_t_y(!c) = resids_t_y(!c) - (sum_resids_t_y/nobs_t)
resids_f_y(!c) = resids_f_y(!c) - (sum_resids_f_y/nobs_f)
next

for !id=1 to 2
vector(2) coef_restrict_t_y(!id) = restricted_t_y.@coef(!id)
next

for !ie=1 to 2
vector(2) coef_restrict_f_y(!ie) = restricted_f_y.@coef(!ie)
next

' ===== Bootstrap replication start here =====
for !ib=1 to lnrep_b ' Bootstrap replication set for 10,000.
smpl @all
series y_t_b = y
series dy_t_b = dy

series y_f_b = y

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series dy_f_b = dy

group gu resids_t_y resids_f_y
gu.resample(dropna, outsmpl=%firstperiod %lastperiod, name=gu_b)

model a
!start = @dtoo(%firstperiod) + 1
%start = @otod(!start)
smpl %start %lastperiod

a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + coef_restrict_t_y(2) + resids_t_y_b
a.append y_t_b = y_t_b(-1) + dy_t_b

a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + coef_restrict_f_y(2) + resids_f_y_b
a.append y_f_b = y_f_b(-1) + dy_f_b

a.scenario "actuals"
a.solve

smpl %firstperiod %lastperiod
equation bootstrap_t_y.ls dy_t_b y_t_b(-1) x1(-1) c
scalar tstat_b = bootstrap_t_y.@tstat(1)

tstat_b_dist(lib) = tstat_b

smpl %firstperiod %lastperiod
equation bootstrap_f_y.ls dy_f_b y_f_b(-1) x1(-1) c
freeze(mode=overwrite, fstat_x_b_table) bootstrap_f_y.wald c(2)=0
scalar fstat_b = @val(fstat_x_b_table(7,2))

fstat_b_dist(lib) = fstat_b
next
else
if %cond_y = "01" then
smpl %firstperiod %lastperiod
equation eq_opt_y.ls dy y(-1) x1(-1) dx1(-1 to -!opt_q) c
scalar tstat_y = eq_opt_y.@tstat(1) ' Obtain the testing t statistic.
freeze(mode=overwrite, fstat_x_table) eq_opt_y.wald c(2)=0
scalar fstat_y = @val(fstat_x_table(7,2)) ' Obtain the testing F statistic.

' ===== Bootstrap start here =====
smpl %firstperiod %lastperiod
' Estimate equation with restriction of null y(-1) for t test and x(-1) for F test.
equation restricted_t_y.ls dy x1(-1) dx1(-1 to -!opt_q) c ' Impose y(-1) = 0.
equation restricted_f_y.ls dy y(-1) dx1(-1 to -!opt_q) c ' Impose x(-1) = 0.

restricted_t_y.makesresids resids_t_y
restricted_f_y.makesresids resids_f_y

' Recenter residuals
scalar sum_resids_t_y = @csum(resids_t_y)
scalar sum_resids_f_y = @csum(resids_f_y)

scalar nobs_t = resids_t_y.@obs
scalar nobs_f = resids_f_y.@obs

for !c=@dtoo(%firstperiod) to @dtoo(%lastperiod)
resids_t_y(!c) = resids_t_y(!c) - (sum_resids_t_y/nobs_t)
resids_f_y(!c) = resids_f_y(!c) - (sum_resids_f_y/nobs_f)
next

!in = 2+!opt_q
for !id=1 to !in
vector(!id) coef_restrict_t_y(!id) = restricted_t_y.@coef(!id)
next

for !ie=1 to !in

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vector(!ie) coef_restrict_f_y(!ie) = restricted_f_y.@coef(!ie)
next

' ===== Bootstrap replication start here =====
for !ib=1 to !nrep_b          ' Bootstrap replication set for 10,000.
  smpl @all
  series y_t_b = y
  series dy_t_b = dy
  series dify_t_b = 0

  series y_f_b = y
  series dy_f_b = dy
  series dify_f_b = 0

  group gu resids_t_y resids_f_y
  gu.resample(dropna, outsmpl=%firstperiod %lastperiod, name=gu_b)

  model a
  !start = @dtoo(%firstperiod) + !opt_lag + 1
  %start = @otod(!start)
  smpl %start %lastperiod
  if !opt_q = 1 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1)
  else
  if !opt_q = 2 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2)
  else
  if !opt_q = 3 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-
3)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-
3)
  else
  if !opt_q = 4 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-
3) + coef_restrict_t_y(5)*dx1(-4)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-
3) + coef_restrict_f_y(5)*dx1(-4)
  else
  if !opt_q = 5 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-
3) + coef_restrict_t_y(5)*dx1(-4) + coef_restrict_t_y(6)*dx1(-5)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-
3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5)
  else
  if !opt_q = 6 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-
3) + coef_restrict_t_y(5)*dx1(-4) + coef_restrict_t_y(6)*dx1(-5) + coef_restrict_t_y(7)*dx1(-6)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-
3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5) + coef_restrict_f_y(7)*dx1(-6)
  else
  if !opt_q = 7 then
    a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-
3) + coef_restrict_t_y(5)*dx1(-4) + coef_restrict_t_y(6)*dx1(-5) + coef_restrict_t_y(7)*dx1(-6) +
coef_restrict_t_y(8)*dx1(-7)

    a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-
3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5) + coef_restrict_f_y(7)*dx1(-6) +
coef_restrict_f_y(8)*dx1(-7)

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else
if !opt_q = 8 then
a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-3) + coef_restrict_t_y(5)*dx1(-4) + coef_restrict_t_y(6)*dx1(-5) + coef_restrict_t_y(7)*dx1(-6) + coef_restrict_t_y(8)*dx1(-7) + coef_restrict_t_y(9)*dx1(-8)

a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5) + coef_restrict_f_y(7)*dx1(-6) + coef_restrict_f_y(8)*dx1(-7) + coef_restrict_f_y(9)*dx1(-8)
else
if !opt_q = 9 then
a.append dify_t_b = coef_restrict_t_y(2)*dx1(-1) + coef_restrict_t_y(3)*dx1(-2) + coef_restrict_t_y(4)*dx1(-3) + coef_restrict_t_y(5)*dx1(-4) + coef_restrict_t_y(6)*dx1(-5) + coef_restrict_t_y(7)*dx1(-6) + coef_restrict_t_y(8)*dx1(-7) + coef_restrict_t_y(9)*dx1(-8) + coef_restrict_t_y(10)*dx1(-9)

a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5) + coef_restrict_f_y(7)*dx1(-6) + coef_restrict_f_y(8)*dx1(-7) + coef_restrict_f_y(9)*dx1(-8) + coef_restrict_f_y(10)*dx1(-9)
else
if !opt_q = 10 then
a.append dify_f_b = coef_restrict_f_y(2)*dx1(-1) + coef_restrict_f_y(3)*dx1(-2) + coef_restrict_f_y(4)*dx1(-3) + coef_restrict_f_y(5)*dx1(-4) + coef_restrict_f_y(6)*dx1(-5) + coef_restrict_f_y(7)*dx1(-6) + coef_restrict_f_y(8)*dx1(-7) + coef_restrict_f_y(9)*dx1(-8) + coef_restrict_f_y(10)*dx1(-9) + coef_restrict_f_y(11)*dx1(-10)
endif
endif
endif
endif
endif
endif
endif
endif
endif
endif

if !opt_q = 1 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(3) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(3) + resids_f_y_b
else
if !opt_q = 2 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(4) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(4) + resids_f_y_b
else
if !opt_q = 3 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(5) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(5) + resids_f_y_b
else
if !opt_q = 4 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(6) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(6) + resids_f_y_b
else
if !opt_q = 5 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(7) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(7) + resids_f_y_b
else
if !opt_q = 6 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(8) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(8) + resids_f_y_b
else
if !opt_q = 7 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(9) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(9) + resids_f_y_b
else
if !opt_q = 8 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(10) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(10) + resids_f_y_b
else

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if !opt_q = 9 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(11) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(11) + resids_f_y_b
else
if !opt_q = 10 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_t_b + coef_restrict_t_y(12) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_f_b + coef_restrict_f_y(12) + resids_f_y_b
endif
endif
endif
endif
endif
endif
endif
endif
endif

a.append y_t_b = y_t_b(-1) + dy_t_b
a.append y_f_b = y_f_b(-1) + dy_f_b

a.scenario "actuals"
a.solve

    smpl %firstperiod %lastperiod
    equation bootstrap_t_y.ls dy_t_b y_t_b(-1) x1(-1) dx1(-1 to -!opt_q) c
    scalar tstat_b = bootstrap_t_y.@tstat(1)

    tstat_b_dist(lib) = tstat_b

    smpl %firstperiod %lastperiod
    equation bootstrap_f_y.ls dy_f_b y_f_b(-1) x1(-1) dx1(-1 to -!opt_q) c
    freeze(mode=overwrite, fstat_x_b_table) bootstrap_f_y.wald c(2)=0
    scalar fstat_b = @val(fstat_x_b_table(7,2))

    fstat_b_dist(lib) = fstat_b
next
else
if %cond_y = "10" then
    smpl %firstperiod %lastperiod
    equation eq_opt_y.ls dy y(-1) x1(-1) dy(-1 to -!opt_p) c
    scalar tstat_y = eq_opt_y.@tstat(1) ' Obtain the testing t statistic.
    freeze(mode=overwrite, fstat_x_table) eq_opt_y.wald c(2)=0
    scalar fstat_y = @val(fstat_x_table(7,2)) ' Obtain the testing F statistic.

    ' ===== Bootstrap start here =====
    smpl %firstperiod %lastperiod
    ' Estimate equation with restriction of null y(-1) for t test and x(-1) for F test.
    equation restricted_t_y.ls dy x1(-1) dy(-1 to -!opt_p) c ' Impose y(-1) = 0.
    equation restricted_f_y.ls dy y(-1) dy(-1 to -!opt_p) c ' Impose x(-1) = 0.

    restricted_t_y.makesresids resids_t_y
    restricted_f_y.makesresids resids_f_y

    ' Recenter residuals
    scalar sum_resids_t_y = @csum(resids_t_y)
    scalar sum_resids_f_y = @csum(resids_f_y)

    scalar nobs_t = resids_t_y.@obs
    scalar nobs_f = resids_f_y.@obs

    for !c=@dtoo(%firstperiod) to @dtoo(%lastperiod)
    resids_t_y(!c) = resids_t_y(!c) - (sum_resids_t_y/nobs_t)
    resids_f_y(!c) = resids_f_y(!c) - (sum_resids_f_y/nobs_f)
    next

!in = 2+!opt_p

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for !lid=1 to !lin
vector(!lid) coef_restrict_t_y(!lid) = restricted_t_y.@coef(!lid)
next

for !lie=1 to !lin
vector(!lie) coef_restrict_f_y(!lie) = restricted_f_y.@coef(!lie)
next

' ===== Bootstrap replication start here =====
'
pagestruct(end = 5000+@dtoo(%lastperiod))
for !lib=1 to !nrep_b ' Bootstrap replication set for 10,000.
smpl @all
series y_t_b = y
series dy_t_b = dy
series dify_t_b = 0

series y_f_b = y
series dy_f_b = dy
series dify_f_b = 0

group gu resids_t_y resids_f_y
gu.resample(dropna, outsmpl=%firstperiod %lastperiod, name=gu_b)

model a
!lstart = @dtoo(%firstperiod) + !opt_lag + 1
%start = @otod(!lstart)
smpl %start %lastperiod
if !opt_p = 1 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1)
else
if !opt_p = 2 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2)
else
if !opt_p = 3 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3)
else
if !opt_p = 4 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4)
else
if !opt_p = 5 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5)
else
if !opt_p = 6 then
a.append dify_t_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
coef_restrict_t_y(7)*dy_t_b(-6)

a.append dify_f_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6)
else

```





```
restricted_f_y.makesresids resids_f_y
```

```
' Recenter residuals
```

```
scalar sum_resids_t_y = @csum(resids_t_y)
```

```
scalar sum_resids_f_y = @csum(resids_f_y)
```

```
scalar nobs_t = resids_t_y.@obs
```

```
scalar nobs_f = resids_f_y.@obs
```

```
for !c=@dtoo(%firstperiod) to @dtoo(%lastperiod)
```

```
resids_t_y(!c) = resids_t_y(!c) - (sum_resids_t_y/nobs_t)
```

```
resids_f_y(!c) = resids_f_y(!c) - (sum_resids_f_y/nobs_f)
```

```
next
```

```
lin = 2+!opt_p+!opt_q
```

```
for !lid=1 to lin
```

```
vector(!lid) coef_restrict_t_y(!lid) = restricted_t_y.@coef(!lid)
```

```
next
```

```
for !lie=1 to lin
```

```
vector(!lie) coef_restrict_f_y(!lie) = restricted_f_y.@coef(!lie)
```

```
next
```

```
' ===== Bootstrap replication start here =====
```

```
for !lib=1 to !nrep_b ' Bootstrap replication set for 10,000.
```

```
smpl @all
```

```
series y_t_b = y
```

```
series dy_t_b = dy
```

```
series dify_ty_b = 0
```

```
series dif_tx_b = 0
```

```
series y_f_b = y
```

```
series dy_f_b = dy
```

```
series dify_fy_b = 0
```

```
series dify_fx_b = 0
```

```
group gu resids_t_y resids_f_y
```

```
gu.resample(dropna, outsmpl=%firstperiod %lastperiod, name=gu_b)
```

```
!totallag = !opt_p + !opt_q ' Total lags for the differenced terms.
```

```
model a
```

```
!start = @dtoo(%firstperiod) + !opt_lag + 1
```

```
%start = @otod(!start)
```

```
smpl %start %lastperiod
```

```
if !opt_p = 1 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1)
```

```
else
```

```
if !opt_p = 2 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2)
```

```
else
```

```
if !opt_p = 3 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
```

```
coef_restrict_t_y(4)*dy_t_b(-3)
```

```
else
```

```
if !opt_p = 4 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
```

```
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4)
```

```
else
```

```
if !opt_p = 5 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
```

```
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5)
```

```
else
```

```
if !opt_p = 6 then
```

```
    a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
```

```
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
```

```
coef_restrict_t_y(7)*dy_t_b(-6)
```

```

else
if !opt_p = 7 then
a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
coef_restrict_t_y(7)*dy_t_b(-6) + coef_restrict_t_y(8)*dy_t_b(-7)
else
if !opt_p = 8 then
a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
coef_restrict_t_y(7)*dy_t_b(-6) + coef_restrict_t_y(8)*dy_t_b(-7) + coef_restrict_t_y(9)*dy_t_b(-8)
else
if !opt_p = 9 then
a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
coef_restrict_t_y(7)*dy_t_b(-6) + coef_restrict_t_y(8)*dy_t_b(-7) + coef_restrict_t_y(9)*dy_t_b(-8) +
coef_restrict_t_y(10)*dy_t_b(-9)
else
if !opt_p = 10 then
a.append dify_ty_b = coef_restrict_t_y(2)*dy_t_b(-1) + coef_restrict_t_y(3)*dy_t_b(-2) +
coef_restrict_t_y(4)*dy_t_b(-3) + coef_restrict_t_y(5)*dy_t_b(-4) + coef_restrict_t_y(6)*dy_t_b(-5) +
coef_restrict_t_y(7)*dy_t_b(-6) + coef_restrict_t_y(8)*dy_t_b(-7) + coef_restrict_t_y(9)*dy_t_b(-8) +
coef_restrict_t_y(10)*dy_t_b(-9) + coef_restrict_t_y(11)*dy_t_b(-10)
endif
endif
endif
endif
endif
endif
endif
endif

if !opt_q = 1 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1)
else
if !opt_q = 2 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2)
else
if !opt_q = 3 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3)
else
if !opt_q = 4 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3) + coef_restrict_t_y(!opt_p+5)*dx1(-4)
else
if !opt_q = 5 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3) + coef_restrict_t_y(!opt_p+5)*dx1(-4) + coef_restrict_t_y(!opt_p+6)*dx1(-5)
else
if !opt_q = 6 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3) + coef_restrict_t_y(!opt_p+5)*dx1(-4) + coef_restrict_t_y(!opt_p+6)*dx1(-5) +
coef_restrict_t_y(!opt_p+7)*dx1(-6)
else
if !opt_q = 7 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3) + coef_restrict_t_y(!opt_p+5)*dx1(-4) + coef_restrict_t_y(!opt_p+6)*dx1(-5) +
coef_restrict_t_y(!opt_p+7)*dx1(-6) + coef_restrict_t_y(!opt_p+8)*dx1(-7)
else
if !opt_q = 8 then
a.append dify_tx_b = coef_restrict_t_y(!opt_p+2)*dx1(-1) + coef_restrict_t_y(!opt_p+3)*dx1(-2) +
coef_restrict_t_y(!opt_p+4)*dx1(-3) + coef_restrict_t_y(!opt_p+5)*dx1(-4) + coef_restrict_t_y(!opt_p+6)*dx1(-5) +
coef_restrict_t_y(!opt_p+7)*dx1(-6) + coef_restrict_t_y(!opt_p+8)*dx1(-7) + coef_restrict_t_y(!opt_p+9)*dx1(-8)
else
if !opt_q = 9 then

```

```

a.append dify_tx_b = coef_restrict_t_y(lopt_p+2)*dx1(-1) + coef_restrict_t_y(lopt_p+3)*dx1(-2) +
coef_restrict_t_y(lopt_p+4)*dx1(-3) + coef_restrict_t_y(lopt_p+5)*dx1(-4) + coef_restrict_t_y(lopt_p+6)*dx1(-5) +
coef_restrict_t_y(lopt_p+7)*dx1(-6) + coef_restrict_t_y(lopt_p+8)*dx1(-7) + coef_restrict_t_y(lopt_p+9)*dx1(-8) +
coef_restrict_t_y(lopt_p+10)*dx1(-9)
else
if !opt_q = 10 then
a.append dify_tx_b = coef_restrict_t_y(lopt_p+2)*dx1(-1) + coef_restrict_t_y(lopt_p+3)*dx1(-2) +
coef_restrict_t_y(lopt_p+4)*dx1(-3) + coef_restrict_t_y(lopt_p+5)*dx1(-4) + coef_restrict_t_y(lopt_p+6)*dx1(-5) +
coef_restrict_t_y(lopt_p+7)*dx1(-6) + coef_restrict_t_y(lopt_p+8)*dx1(-7) + coef_restrict_t_y(lopt_p+9)*dx1(-8) +
coef_restrict_t_y(lopt_p+10)*dx1(-9) + coef_restrict_t_y(lopt_p+11)*dx1(-10)
endif
endif
endif
endif
endif
endif
endif
endif
endif
endif

if !opt_p = 1 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1)
else
if !opt_p = 2 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2)
else
if !opt_p = 3 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3)
else
if !opt_p = 4 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4)
else
if !opt_p = 5 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5)
else
if !opt_p = 6 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6)
else
if !opt_p = 7 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6) + coef_restrict_f_y(8)*dy_f_b(-7)
else
if !opt_p = 8 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6) + coef_restrict_f_y(8)*dy_f_b(-7) + coef_restrict_f_y(9)*dy_f_b(-8)
else
if !opt_p = 9 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6) + coef_restrict_f_y(8)*dy_f_b(-7) + coef_restrict_f_y(9)*dy_f_b(-8) +
coef_restrict_f_y(10)*dy_f_b(-9)
else
if !opt_p = 10 then
a.append dify_fy_b = coef_restrict_f_y(2)*dy_f_b(-1) + coef_restrict_f_y(3)*dy_f_b(-2) +
coef_restrict_f_y(4)*dy_f_b(-3) + coef_restrict_f_y(5)*dy_f_b(-4) + coef_restrict_f_y(6)*dy_f_b(-5) +
coef_restrict_f_y(7)*dy_f_b(-6) + coef_restrict_f_y(8)*dy_f_b(-7) + coef_restrict_f_y(9)*dy_f_b(-8) +
coef_restrict_f_y(10)*dy_f_b(-9) + coef_restrict_f_y(11)*dy_f_b(-10)
endif
endif
endif
endif
endif
endif
endif
endif
endif
endif

```

```

endif
endif
endif
endif
endif
endif
endif

if !opt_q = 1 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1)
else
if !opt_q = 2 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2)
else
if !opt_q = 3 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3)
else
if !opt_q = 4 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4)
else
if !opt_q = 5 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5)
else
if !opt_q = 6 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5) +
coef_restrict_f_y(!opt_p+7)*dx1(-6)
else
if !opt_q = 7 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5) +
coef_restrict_f_y(!opt_p+7)*dx1(-6) + coef_restrict_f_y(!opt_p+8)*dx1(-7)
else
if !opt_q = 8 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5) +
coef_restrict_f_y(!opt_p+7)*dx1(-6) + coef_restrict_f_y(!opt_p+8)*dx1(-7) + coef_restrict_f_y(!opt_p+9)*dx1(-8)
else
if !opt_q = 9 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5) +
coef_restrict_f_y(!opt_p+7)*dx1(-6) + coef_restrict_f_y(!opt_p+8)*dx1(-7) + coef_restrict_f_y(!opt_p+9)*dx1(-8) +
coef_restrict_f_y(!opt_p+10)*dx1(-9)
else
if !opt_q = 10 then
  a.append dify_fx_b = coef_restrict_f_y(!opt_p+2)*dx1(-1) + coef_restrict_f_y(!opt_p+3)*dx1(-2) +
coef_restrict_f_y(!opt_p+4)*dx1(-3) + coef_restrict_f_y(!opt_p+5)*dx1(-4) + coef_restrict_f_y(!opt_p+6)*dx1(-5) +
coef_restrict_f_y(!opt_p+7)*dx1(-6) + coef_restrict_f_y(!opt_p+8)*dx1(-7) + coef_restrict_f_y(!opt_p+9)*dx1(-8) +
coef_restrict_f_y(!opt_p+10)*dx1(-9) + coef_restrict_f_y(!opt_p+11)*dx1(-10)
endif
endif
endif
endif
endif
endif
endif
endif

if !totalag = 2 then
a.append dy_t_b = coef_restrict_t_y(1)*x1(-1) + dify_ty_b + dify_tx_b + coef_restrict_t_y(4) + resids_t_y_b
a.append dy_f_b = coef_restrict_f_y(1)*y_f_b(-1) + dify_fy_b + dify_fx_b + coef_restrict_f_y(4) + resids_f_y_b

```



