Reverse Engineering the Eview Code in the FRB/US Model

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June 19, 2016

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FRB/US Package

2.1 example1 program

3 ⟨*frbus example1* 3⟩≡ (186c)

```
' Program for simple simulation under VAR expectations
'
' See FRB/US Simulation Basics document for information about
' this program

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2030q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model name and location
  %varmod = "stdver"
  %varpath = "../mods/"

' Input datbase
  %dbin  = "../data/longbase"

' Simulation range
  %simstart = "2020q1"
```

```
%simend   = "2025q4"


' ***************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ***************************************************************

' Load equations and coefficients
ld_frbus_eqs(modelname=%varmod,modelpath=%varpath)
ld_frbus_cfs(modelname=%varmod,modelpath=%varpath)

' Load data
dbopen %dbin as longbase
fetch(d=longbase) *

' Set monetary policy rule
smpl @all
call set_mp("dmpintay")

' Turn off zero bound and policy thresholds; hold policymaker's
' perceived equilibrium real interest rate constant
smpl @all
dmptrsh = 0
rffmin = -9999
drstar = 0

' Set fiscal policy
smpl @all
call set_fp("dfpsrp")

' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
call group2zero("endog_aerr")

' Standard solution options
{%varmod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
%suftrk = "_0"
smpl %simstart %simend
{%varmod}.addassign @all
{%varmod}.addinit(v=n) @all
{%varmod}.scenario(n,a={%suftrk}) "track"
```

```
    {%varmod}.solve
    scalar mm = @max(@abs(xgap{%suftrk}-xgap))
    if mm > .0001 then
      statusline dynamic tracking simulation failed for {%varmod}
      stop
      endif

  ' ************************************************************
  ' Simulate a shock to monetary policy rule
  ' ************************************************************

    %sufsim = "_1"
    {%varmod}.scenario(n,a={%sufsim}) "sim"

    smpl %simstart %simstart
    rffintay_aerr = rffintay_aerr + 1

    smpl %simstart %simend
    {%varmod}.solve


  '************************************************************
  ' Make a graph
  '************************************************************

    smpl %simstart %simend
    series zero = 0
    series d_rff = rff{%sufsim} - rff
    series d_rg10 = rg10{%sufsim} - rg10
    series d_lur = lur{%sufsim} - lur
    series d_pic4 = pic4{%sufsim} - pic4

    graph fig1a.line zero d_rff
    fig1a.addtext(t,just(c),font("arial",12)) Federal Funds Rate
    fig1a.legend -display

    graph fig1b.line zero d_rg10
    fig1b.addtext(t,just(c),font("arial",12)) 10-Year Treasury Yield
    fig1b.legend -display

    graph fig1c.line zero d_lur
    fig1c.addtext(t,just(c),font("arial",12)) Unemployment Rate
    fig1c.legend -display

    graph fig1d.line zero d_pic4
    fig1d.addtext(t,just(c),font("arial",12)) Inflation Rate (4-Quarter)
```

```
fig1d.legend -display

graph fig1.merge fig1a fig1b fig1c fig1d
fig1.addtext(t,just(c),font("Arial",16)) Macroeconomic Effects of Funds Rate Pertu
fig1.align(2,1,1.25)
show fig1
```

Defines:
example1, used in chunk 168.
Uses group2zero 81a, groupnew 82, ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, set_fp 84, and set_mp 85a.

2.2 example2 program

7 ⟨*frbus example2* 7⟩≡ (186d)

```
' Program for simple simulation with MCE expectations
'
' The switch variables %mcvars_wp and %mcvars_all control whether
' the assumption of MC expectations extends beyond the financial
' sector

' See the Simulation Basics document for information about
' this program


' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library
  include ../subs/mce_solve_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model names and locations
  %varmod = "stdver"
  %varpath = "../mods/"
  %mcemod = "pfver"
  %mcepath = "../mods/"

' Input datbase
  %dbin  = "../data/longbase"

' Simulation range
  %simstart = "2020q1"
  %simend   = "2069q4"


' ************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ************************************************************
```

```
' Specify MC expectations variables
%mcvars_wp = "yes"
%mcvars_all = "no"

' MCE asset pricing
%zvars = "zdivgr zgap05 zgap10 zgap30 zrff5 zrff10 zrff30 zpi10 zpi10f zpic30 zpib5

' MCE elsewhere
if %mcvars_wp = "yes" and %mcvars_all = "no" then
  %zvars = %zvars + "zpicxfe zpieci "
  endif
if %mcvars_all = "yes" then
  %zvars = %zvars + "zpicxfe zpieci "
  %zvars = %zvars + "zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvpi zvps zxbd zxbi zxbs z
  endif

' Load equations and coefficients
call mce_load_frbus("mce_vars=%zvars,mod_b=%varmod,path_b=%varpath,mod_f=%mcemod,pa

' Load data
dbopen %dbin as longdata
fetch(d=longdata) *

' Data for extra variables associated with MC expectations
smpl @all
call make_frbus_mcevars(%zvars)

' Set monetary policy
smpl @all
call set_mp("dmpintay")

' Turn off zero bound and policy thresholds; hold policymaker's
' perceived equilibrium real interest rate constant
smpl @all
dmptrsh = 0
rffmin = -9999
drstar = 0

' Set fiscal policy
smpl @all
call set_fp("dfpsrp")

' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
```

```
  call group2zero("endog_aerr")

' Standard solution options
  {%varmod}.solveopt(o=b,g=12,z=1e-12)
  {%mcemod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
  %suftrk = "_0"
  smpl %simstart %simend
  {%varmod}.addassign @all
  {%varmod}.addinit(v=n) @all
  {%varmod}.scenario(n,a={%suftrk}) "track"
  {%varmod}.solve
  scalar mm = @max(@abs(xgap{%suftrk}-xgap))
  if mm > .0001 then
    statusline dynamic tracking simulation failed for {%varmod}
    stop
    endif
  {%mcemod}.addassign @all
  {%mcemod}.addinit(v=n) @all

' ************************************************************
' Simulate a monetary policy shock
' ************************************************************

  %sufsim = "_1"
  {%varmod}.scenario(n,a={%sufsim}) "sim"
  {%mcemod}.scenario(n,a={%sufsim}) "sim"

  smpl %simstart %simstart
  rffintay_a = rffintay_a + 1

  %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
  %algstr = "meth=qnewton"
  %simstr = "type=single"
  smpl %simstart %simend
  call mce_run(%modstr,%algstr,%simstr)


'************************************************************
' Make a graph
'************************************************************

  smpl %simstart %simstart + 39
  series zero = 0
  series d_rff = rff{%sufsim} - rff
```

```
series d_rg10 = rg10{%sufsim} - rg10
series d_lur = lur{%sufsim} - lur
series d_pic4 = pic4{%sufsim} - pic4

graph fig1a.line zero d_rff
fig1a.addtext(t,just(c),font("arial",12)) Federal Funds Rate
fig1a.legend -display

graph fig1b.line zero d_rg10
fig1b.addtext(t,just(c),font("arial",12)) 10-Year Treasury Yield
fig1b.legend -display

graph fig1c.line zero d_lur
fig1c.addtext(t,just(c),font("arial",12)) Unemployment Rate
fig1c.legend -display

graph fig1d.line zero d_pic4
fig1d.addtext(t,just(c),font("arial",12)) Inflation Rate (4-Quarter)
fig1d.legend -display

graph fig1.merge fig1a fig1b fig1c fig1d
%title = " Macroeconomic Effects of Funds Rate Shock\r"
if %mcvars_wp = "no" and %mcvars_all = "no" then
  %title = %title + "(MC Expectations in Asset Pricing)"
  endif
if %mcvars_wp = "yes" and %mcvars_all = "no" then
  %title = %title + "(MC Expectations in Asset Pricing and Price-Wage Setting)"
  endif
if %mcvars_all = "yes" then
  %title = %title + "(MC Expectations in All Sectors)"
  endif
fig1.addtext(t,just(c),font("Arial",16)) {%title}
fig1.align(2,1,1.25)
show fig1
```

Defines:
example2, used in chunk 168.
Uses group2zero 81a, groupnew 82, make_frbus_mcevars 164, mce_load_frbus 160, mce_run 88, mce_solve_library 210 215a, set_fp 84, and set_mp 85a.

2.3 example3 program

11 ⟨*frbus example3* 11⟩≡ (187a)

```
' Program for simulation under VAR expectations that illustrates how
' to set the monetary policy options that impose the zero lower bound
' on the funds rate and delay the liftoff of the funds rate from the
' ZLB until either the unemployment rate falls below a threshold or
' inflation rises above a threshold.
'
' See FRB/US Simulation Basics document for general information about
' this program.

' Additional notes:

' 1. The scenario involves a set of negative aggregate demand
' shocks and a positive risk premium shock that start in 2003q3,
' when the baseline (historical) funds rate is about one percent.
' The shocks are equal to the equation errors actually observed
' in the four quarters starting in 2008q4.

' 2. To impose the ZLB set %zb = "yes" (rather than "no")

' 3. To impose the policy liftfoff threshold conditions set both
' %zb = "yes" and %threshold = "yes".  For illustrative purposes
' and reflecting the baseline conditions in 2003 and the years
' that immediately follow, the inflation threshold is set to 3.0
' and the unemployment threshold is set to 7.0, subject to the
' the adjustments described next.

' 4. Because the threshold conditions only make sense once the ZLB is
' binding, unemployment is above its threshold level (lurtrsh),
' and inflation is below its threshold (pitrsh), which is not the
' case in the initial simulation quarters, the program turns on the
' threshold code (using dmptrsh) in the 5th simulation quarter,
' at which point these conditions hold. In addition, for the threshold
' code to work properly, the endogenous switch variable dmptr must be
' zero in the quarter prior to the quarter in which the threshold code is
' turned on.  This is accomplished by setting the baseline data on dmptr
' to zero and by setting the unemployment and inflation thresholds
' (lurtrsh, pitrsh) to values in the first four simulation quarters that
' would not flip the dmptr switch to one.

' 4. Choose one of the five available policy rules by setting
' %policy to one of rffintay, rfftay, rfftlr, rffalt, or rffgen.

' 5. If neither the ZLB or thresholds are imposed, the monetary policy
```

```
' equations have baseline-tracking adds and the simulation is
' a standard deviations-from-baseline exercise.

' 6. If either the ZLB or thresholds are imposed, the add factors on
' monetary policy equations are set to zero after the tracking adds
' are computed so that the ZLB and threshold conditions are based on the
' actual simulated outcomes for the funds rate and inflation and unemployment,
' not their deviations from baseline.

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2012q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model name and location
  %varmod = "stdver"
  %varpath = "../mods/"

' Input datbase
  %dbin  = "../data/longbase"

' Simulation range
  %simstart = "2003q3"
  %simend   = "2008q2"

' Policy
  %zb = "yes"
  %threshold = "yes"
  %policy = "rfftay"


' ************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ************************************************************

' Load equations and coefficients
  ld_frbus_eqs(modelname=%varmod,modelpath=%varpath)
```

```
    ld_frbus_cfs(modelname=%varmod,modelpath=%varpath)

  ' Load data
    dbopen %dbin as longbase
    fetch(d=longbase) *

  ' Set monetary policy rule
    smpl @all
    %policydmp = @replace(%policy,"rff","dmp")
    call set_mp(%policydmp)

  ' Set ZLB
    if %zb = "yes" then
      rffmin = .125
      else
      rffmin = -9999
      endif

  ' Set threshold variables
    if %threshold = "yes" then
      if %zb = "no" then
        @uiprompt("When policy thresholds are imposed, the zero bound must also be imposed")
        stop
        endif
      smpl @all
      call dateshift(%simstart,%quarter4,3)
    ' thresholds (dmptrsh and dmptr) not active in first 4 qtrs
      smpl %simstart - 1 %quarter4
      dmptrsh = 0
      lurtrsh = -9999
      pitrsh = 9999
      dmptr = 0
    ' thresholds (dmptrsh and dmptr) active starting in qtr 5
      smpl %quarter4 + 1 %simend
      dmptrsh = 1
      lurtrsh = 7.0
      pitrsh = 3.0
      smpl @all
      else
      smpl @all
      dmptrsh = 0
      endif

    smpl @all
    drstar = 0
```

```
' Set fiscal policy
smpl @all
call set_fp("dfpsrp")

' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
call group2zero("endog_aerr")

' Standard solution options
{%varmod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
%suftrk = "_0"
smpl %simstart 2012q4
{%varmod}.addassign @all
{%varmod}.addinit(v=n) @all
{%varmod}.scenario(n,a={%suftrk}) "track"
{%varmod}.solve
scalar mm = @max(@abs(xgap{%suftrk}-xgap))
if mm > .0001 then
  statusline dynamic tracking simulation failed for {%varmod}
  stop
  endif

' Set monetary policy add factors to zero when ZLB or threshold are
' imposed

if %zb = "yes" then
  smpl @all
  {%policy}_a = 0
  rffrule_a = 0
  rffe_a = 0
  if %threshold = "yes" then
    dmptpi_a = 0
    dmptlur_a = 0
    dmptmax_a = 0
    dmptr_a = 0
    endif
  endif

' ************************************************************
' Simulation
' ************************************************************
```

```
  %sufsim = "_1"
  {%varmod}.scenario(n,a={%sufsim}) "sim"

' shock values are taken from equation residuals for 2008q4-2009q3
  eco_a.fill(o=%simstart) -.006, -.006, -.011, -.001
  ecd_a.fill(o=%simstart) -.091, -.018, -.021,  .029
  eh_a.fill(o=%simstart)  -.076, -.078, -.040,  .073
  epd_a.fill(o=%simstart) -.096, -.062,  .014,  .032
  eps_a.fill(o=%simstart) -.018, -.046, -.036, -.017
  rbbbp_a.fill(o=%simstart) 2.70, 0.38, -0.89, -1.35

  smpl %simstart %simend
  {%varmod}.solve


'***********************************************************
' Make a graph
'***********************************************************

  smpl %simstart %simend

  graph fig1a.line rff rff{%sufsim}
  fig1a.addtext(t,just(c),font("arial",12)) Federal Funds Rate
  fig1a.legend -display

  graph fig1b.line rg10 rg10{%sufsim}
  fig1b.addtext(t,just(c),font("arial",12)) 10-Year Treasury Yield
  fig1b.legend -display

  graph fig1c.line lur lur{%sufsim}
  fig1c.addtext(t,just(c),font("arial",12)) Unemployment Rate
  fig1c.legend -display

  graph fig1d.line pic4 pic4{%sufsim}
  fig1d.addtext(t,just(c),font("arial",12)) Inflation Rate (4-Quarter)
  fig1d.legend -display

  %title = "Macroeconomic Effects of Negative AD Shock\r(VAR Expectations"
  %title = %title + "; Policy = " + %policy + ")"
  if %zb = "yes" and %threshold = "no" then
    %title = %title + "\r(ZLB Imposed)"
    endif
  if %zb = "yes" and %threshold = "yes" then
    %title = %title + "\r(ZLB and Thresholds Imposed)"
    endif
```

```
graph fig1.merge fig1a fig1b fig1c fig1d
fig1.addtext(t,just(c),font("Arial",16)) {%title}
fig1.addtext(b,just(c),font("Arial",16)) Blue:  Actual;  Red:  Simulated
fig1.align(2,1,1.25)
show fig1
```

Defines:
example3, used in chunk 168.
Uses dateshift 79, group2zero 81a, groupnew 82, ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, set_fp 84, and set_mp 85a.

2.4 example4 program

17 ⟨*frbus example4* 17⟩≡ (187b)

```
' This MCE example program illustrates:
'
' 1. how to use a monetary policy rule that is not one of the policy
'   alternatives included in FRB/US;
' 2. how to add new MCE expectations variables;
' 3. how to drop one of the regular FRB/US equations as part of the process
'   of loading the model

' Most of the code needed illustrate these issues is located between
' the "start of new code" and "end of new code" comments below

' The switch variables %mcvars_wp and %mcvars_all control whether
' the assumption of MC expectations extends beyond the financial
' sector

' See the Simulation Basics document for information about
' this program


' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library
  include ../subs/mce_solve_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model names and locations
  %varmod = "stdver"
  %varpath = "../mods/"
  %mcemod = "pfver"
  %mcepath = "../mods/"

' Input datbase
  %dbin  = "../data/longbase"

' Simulation range
```

```
%simstart = "2010q1"
%simend   = "2069q4"


' ******************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ******************************************************************

' Specify MC expectations variables
%mcvars_wp = "no"
%mcvars_all = "yes"

' MCE asset pricing
%zvars = "zdivgr zgap05 zgap10 zgap30 zrff5 zrff10 zrff30 zpi10 zpi10f zpic30 zpib5

' MCE elsewhere
if %mcvars_wp = "yes" and %mcvars_all = "no" then
  %zvars = %zvars + "zpicxfe zpieci "
  endif
if %mcvars_all = "yes" then
  %zvars = %zvars + "zpicxfe zpieci "
  %zvars = %zvars + "zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvpi zvps zxbd zxbi zxbs z
  endif

' Load equations and coefficients

' drop one of the FRB/US monetary policy rule equations (rffgen) so that it can be
' replaced below with an alternative rule
%allbut = "rffgen"
call mce_load_frbus("mce_vars=%zvars,mod_b=%varmod,path_b=%varpath,mod_f=%mcemod,pa

' Load data
dbopen %dbin as longdata
fetch(d=longdata) *

' ******************************************************************************
' ******************************************************************************
' start of new code (aside from the change above to mce_load_frbus and
'                    the change below to the call to set_mp)

' Code a first-difference interest rate rule as rffgen.  The first-difference rule de
' the expected output gap three quarters ahead (zgap3) and on expected 4-qtr inflatio
' quarters ahead (zpic43).  The name of each new expectation must start with a "z".
{%varmod}.append rffgen-rffgen_aerr = rffe(-1) + .5*(zpic43-pitarg) + .5*(zgap3-zga
```

```
' Add the MCE definitions of zgap3 and zpic43 to the forward-looking model,
' noting that the MCE names of these variables must start with a "w" rather than a "z".
  {%mcemod}.append wgap3-wgap3_aerr = xgap2(3)
  {%mcemod}.append wpic43-wpic43_aerr = picx4(3)
' Add expectations error equations to the MCE model
  {%mcemod}.append ezgap3 = zgap3-wgap3
  {%mcemod}.append ezpic43 = zpic43-wpic43

' Add to the backward-looking model simple equations for the new expectations variables.
' Technically, these equations should be the appropriate VAR expectations formulas, but
' because in this program these expectations will always be MCE, the form of their
' backward-looking identities is not very important.
  {%varmod}.append zgap3-zgap3_aerr = .5*xgap2(-1)
  {%varmod}.append zpic43-zpic43_aerr = .5*picx4(-1)+.5*ptr(-1)

' Add the new MCE variables to the %zvars string
  %zvars = %zvars + " zgap3 zpic43"

' Define baseline values of the new expectations variables
  smpl @all
  series zgap3 = xgap2(3)
  series zpic43 = picx4(3)

' Make sure that the baseline data for rffgen matches the baseline data for rffe
  rffgen = rffe

' end of new code
' ***************************************************************************
' ***************************************************************************

' Data for extra variables associated with MC expectations
  smpl @all
  call make_frbus_mcevars(%zvars)

' Set monetary policy to use the first-difference policy rule (coded as rffgen)
  smpl @all
  call set_mp("dmpgen")

' Turn off zero bound and policy thresholds; hold policymaker's
' perceived equilibrium real interest rate constant
  smpl @all
  dmptrsh = 0
  rffmin = -9999
  drstar = 0

' Set fiscal policy
```

```
  smpl @all
  call set_fp("dfpsrp")

' Set _aerr variables to zero
  smpl @all
  {%varmod}.makegroup(a,n) endog @endog
  call groupnew("endog","_aerr")
  call group2zero("endog_aerr")

' Standard solution options
  {%varmod}.solveopt(o=b,g=12,z=1e-12)
  {%mcemod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
  %suftrk = "_0"
  smpl %simstart %simend
  {%varmod}.addassign @all
  {%varmod}.addinit(v=n) @all
  {%varmod}.scenario(n,a={%suftrk}) "track"
  {%varmod}.solve
  scalar mm = @max(@abs(xgap{%suftrk}-xgap))
  if mm > .0001 then
    statusline dynamic tracking simulation failed for {%varmod}
    stop
    endif
  {%mcemod}.addassign @all
  {%mcemod}.addinit(v=n) @all

' ************************************************************
' Simulate the effects of a one-percent consumption shock
' ************************************************************

  %sufsim = "_1"
  {%varmod}.scenario(n,a={%sufsim}) "sim"
  {%mcemod}.scenario(n,a={%sufsim}) "sim"

  smpl %simstart %simstart
  eco_a = eco_a + .01

  %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
  %algstr = "meth=qnewton"
  %simstr = "type=single"
  smpl %simstart %simend
  call mce_run(%modstr,%algstr,%simstr)
```

```
'*************************************************************
' Make a graph
'*************************************************************

  smpl %simstart %simstart + 39
  series zero = 0
  series d_rff = rff{%sufsim} - rff
  series d_rg10 = rg10{%sufsim} - rg10
  series d_lur = lur{%sufsim} - lur
  series d_pic4 = pic4{%sufsim} - pic4

  graph fig1a.line zero d_rff
  fig1a.addtext(t,just(c),font("arial",12)) Federal Funds Rate
  fig1a.legend -display

  graph fig1b.line zero d_rg10
  fig1b.addtext(t,just(c),font("arial",12)) 10-Year Treasury Yield
  fig1b.legend -display

  graph fig1c.line zero d_lur
  fig1c.addtext(t,just(c),font("arial",12)) Unemployment Rate
  fig1c.legend -display

  graph fig1d.line zero d_pic4
  fig1d.addtext(t,just(c),font("arial",12)) Inflation Rate (4-Quarter)
  fig1d.legend -display

  graph fig1.merge fig1a fig1b fig1c fig1d
  %title = " Macroeconomic Effects of a Shock to Consumption\r"
  if %mcvars_wp = "no" and %mcvars_all = "no" then
    %title = %title + "(MC Expectations in Asset Pricing)"
    endif
  if %mcvars_wp = "yes" and %mcvars_all = "no" then
    %title = %title + "(MC Expectations in Asset Pricing and Price-Wage Setting)"
    endif
  if %mcvars_all = "yes" then
    %title = %title + "(MC Expectations in All Sectors)"
    endif
  fig1.addtext(t,just(c),font("Arial",16)) {%title}
  fig1.align(2,1,1.25)
  show fig1
```

Defines:
  example4, used in chunk 168.
Uses group2zero 81a, groupnew 82, make_frbus_mcevars 164, mce_load_frbus 160, mce_run 88,

2.5 ocpolicy program

23 ⟨*frbus ocpolicy* 23⟩≡ (187c)

```
' Routine to simulate how the SEP baseline forecast would change if
' policymakers commit to a path for the federal funds rate that is
' determined by optimal-control (OC) techniques to minimize a
' quadratic loss function.
'
' Detailed information on the mechanics of the OC algorithm and the
' various required and optional parameters that set up and guide its
' execution is available in the MCE Solve Users Guide in the
' documentation directory.  Most relevant is the part of section 5
' that describes the "opt" simulation type as well as table 7.

' As specified below, the loss function penalizes equally weighted
' squared deviations of the unemployment rate from the natural rate,
' squared deviations of inflation from a 2 percent, and squared
' quarterly changes in the funds rate.

' In the SEP baseline, agents with model-consistent (MC) expectations
' are initially assumed to project that the funds rate will follow the
' baseline path and to set their baseline expectations
' accordingly.  At the start of the optimal control simulation, however,
' these agents immediately and fully revise their expectations to be
' consistent with the revision to the funds rate path that occurs under
' optimal control -- that is, agents have rational expectations and
' announced policy actions are completely credible.
'
' The experiment can be run with the zero lower bound (ZLB) imposed
' (%zerobound = "yes") or not imposed (%zerobound = "no").  When
' the ZLB is imposed, a penalty term is added to the loss function.

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library
  include ../subs/mce_solve_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}
```

```
' FRB/US model names and locations
 %varmod = "stdver"
 %varpath = "../mods/"
 %mcemod = "pfver"
 %mcepath = "../mods/"

' Input datbase
 %dbin  = "../data/longbase"

' Simulation range
 %simstart = "2014q4"
 %simend   = "2070q4"

' Primary loss function parameters:  The value of the policy instrument
' is chosen optimally from %drvstart to %drvend (60 qtrs) to minimize
' the loss function from %evlstart to %evlend (80 qtrs).  The three
' arguments of the period loss function are weighted by the the
' weight parameters and over time losses are discounted at the rate
' %discount
 %evlstart = %simstart
 %drvstart = %simstart
 call dateshift(%evlstart,%evlend,79)
 call dateshift(%drvstart,%drvend,59)
 %discount = ".99"
 %u_weight = "1.0"
 %p_weight = "1.0"
 %r_weight = "1.0"

' Optionally impose the zero lower bound
 %zerobound = "yes"


' ***************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ***************************************************************

' Specify MC expectations variables
 %mcvars_wp = "yes"
 %mcvars_all = "no"

' MCE asset pricing
 %zvars = "zdivgr zgap05 zgap10 zgap30 zrff5 zrff10 zrff30 zpi10 zpi10f zpic30 zpib5

' MCE elsewhere
 if %mcvars_wp = "yes" and %mcvars_all = "no" then
```

```
    %zvars = %zvars + "zpicxfe zpieci "
    endif
  if %mcvars_all = "yes" then
    %zvars = %zvars + "zpicxfe zpieci "
    %zvars = %zvars + "zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvpi zvps zxbd zxnfbi zxnfbs zyh zyh
    endif

' Load equations and coefficients
  call mce_load_frbus("mce_vars=%zvars,mod_b=%varmod,path_b=%varpath,mod_f=%mcemod,path_f=%mcep

' Add a ugap equation
  {%varmod}.append ugap - ugap_aerr = lur - lurnat

' Load data
  dbopen %dbin as longdata
  fetch(d=longdata) *

' Define SEP-consistent ustar and ugap series; this step is needed because
' the baseline value of lurnat may not be fully SEP-consistent in the
' short-to-medium ruun
  smpl @all
  series ustar = lurnat
  smpl %simstart 2025q4
  ustar = 5.35
  smpl @all
  series ugap = lur-ustar
  series ugap_aerr = 0

' Data for extra variables associated with MC expectations
  smpl @all
  call make_frbus_mcevars(%zvars)

' Set monetary policy option (the residual on the equation of
' the chosen option is the OC policy instrument)
  smpl @all
  call set_mp("dmptay")

' Initially turn off zero lower bound; if %zerobound = "yes", it will be
' imposed below by adding a penalty term to the loss function.
  smpl @all
  rffmin = -9999
' Turn off policy thresholds
  dmptrsh = 0
' Let the perceived equilibrium real interest rate vary
  drstar = 1
```

```
' Set fiscal policy so that it is exogenous for first 20 qtrs and then
' turns on debt targeting rule
  smpl %simstart %simstart + 19
  call set_fp("dfpex")
  smpl %simstart + 20 %simend
  call set_fp("dfpdbt")

' Set _aerr variables to zero
  smpl @all
  {%varmod}.makegroup(a,n) endog @endog
  call groupnew("endog","_aerr")
  call group2zero("endog_aerr")

' Standard solution options
  {%varmod}.solveopt(o=b,g=12,z=1e-12)
  {%mcemod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
  %suftrk = "_0"
  smpl %simstart %simend
  {%varmod}.addassign @all
  {%varmod}.addinit(v=n) @all
  {%varmod}.scenario(n,a={%suftrk}) "track"
  {%varmod}.solve
  scalar mm = @max(@abs(xgap{%suftrk}-xgap))
  if mm > .0001 then
    statusline dynamic tracking simulation failed for {%varmod}
    stop
    endif
  {%mcemod}.addassign @all
  {%mcemod}.addinit(v=n) @all



'************************************************************
' optimal policy setup
'************************************************************

' The policy instrument is a time varying constant in the equation
' for the selected policy rule
  group opt_instrus rfftay_aerr

' Loss function variables (unemployment gap, 4-qtr PCE inflation,
' and the first difference of the federal funds rate)
  group opt_targs ugap pic4 delrff
```

```
' The desired paths of the loss function variables are specified in
' series with "_t" suffix.
  smpl @all
  series ugap_t   = 0
  series delrff_t = 0
  series pic4_t   = 2.0

' The weights on the loss function arguments are specified in
' series with "_w" suffix.
  series ugap_w   = @val(%u_weight)
  series pic4_w   =  @val(%p_weight)
  series delrff_w =  @val(%r_weight)

  !discount = @val(%discount)
  smpl %simstart+1 %simend
  ugap_w   = !discount * ugap_w(-1)
  pic4_w   = !discount * pic4_w(-1)
  delrff_w = !discount * delrff_w(-1)

' Zero bound penalty function
  if %zerobound = "yes" then
    {%varmod}.append penalty - penalty_aerr = _
       @recode(rff<(rff_lo_bnd+rff_lo_shift), _
         3.0*((rff_lo_bnd+rff_lo_shift)-rff),  _
         0) _
     + @recode(rff<(rff_lo_bnd+rff_lo_shift), _
       .10*exp(10*(rff-(rff_lo_bnd+rff_lo_shift))), _
       .10*exp(-20*(rff-(rff_lo_bnd+rff_lo_shift))))
    smpl @all
    series rff_lo_bnd = .125
    series rff_lo_shift = .00
    series penalty = 0
    series penalty_aerr = 0
    series rffmin = -9999
    %penalty_weight = "10.0"
    opt_targs.add penalty
    smpl @all
    series penalty_a = 0
    series penalty_t = 0
    series penalty_w = @val(%penalty_weight)
    smpl %simstart+1 %simend
    penalty_w = !discount * penalty_w(-1)
    endif
```

```
'*************************************************************
' optimal policy simulation
'*************************************************************

  %sufcontrol = "_1"

' In %simstr, the "type=opt" string designates a commitment-based
' OC simulation.  The required "instrus" and "targs" keywords point to
' the groups containing the policy instrument(s) and target variables.
' FRB/US simulations of this type generally run much more quickly with
' the newton MCE algorithm than they do with qnewton.
  %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
  %algstr = "jinit=interp(4), meth=newton"
  %simstr = "type=opt,instrus=opt_instrus,targs=opt_targs"
  %simstr = %simstr + ",scen,suf=" + %sufcontrol+ ",solveopt=%sopt"
  %simstr = %simstr + ",lend=" + %evlend + ",iend=" + %drvend + ",lmax=20"
  smpl {%simstart} {%simend}
  call mce_run(%modstr,%algstr,%simstr)

' When the ZLB is imposed, run the OC algorithm a second time,
' after adjusting the intercept of the penalty function,
' to hit ZLB more closely
  if %zerobound = "yes" then
    smpl if rff{%sufcontrol} <.2
    rff_lo_shift = .125 - rff{%sufcontrol}
    %modstr = ""
    %algstr = ""
    %simstr = "type=opt,instrus=opt_instrus,targs=opt_targs"
    %simstr = %simstr + ",solveopt=%sopt"
    %simstr = %simstr + ",lend=" + %evlend + ",iend=" + %drvend + ",lmax=20"
    smpl {%simstart} {%simend}
    call mce_run(%modstr,%algstr,%simstr)
    endif


'*************************************************************
' graph results
'*************************************************************

  call dateshift(%simstart,%graphstart,-8)
  call dateshift(%simstart,%graphend,32)

  smpl %graphstart %graphend
  graph fig1a.line rff{%sufcontrol} rff
  fig1a.options size(7,4.2)
  fig1a.legend display -inbox position(3.8,2.8) font("arial",15)
```

```
fig1a.datelabel format(yy)
fig1a.addtext(6.4,-.30,font("arial",13),keep) percent
fig1a.axis(left) font("arial",15)
fig1a.axis(bottom) font("arial",15)
fig1a.setelem(1) lcolor(red)  legend("optimal control") lwidth(2)
fig1a.setelem(2) lcolor(black) legend("SEP-consistent baseline") lwidth(2)
fig1a.addtext(t,just(c),font("arial",18)) Federal Funds Rate


smpl %graphstart %graphend
graph fig1b.line rg10{%sufcontrol} rg10
fig1b.options size(7,4.2)
fig1b.legend display -inbox position(3.8,2.8) font("arial",15)
fig1b.datelabel format(yy)
fig1b.addtext(6.4,-.30,font("arial",13),keep) percent
fig1b.axis(left) font("arial",15)
fig1b.axis(bottom) font("arial",15)
fig1b.setelem(1) lcolor(red)  legend("optimal control") lwidth(2)
fig1b.setelem(2) lcolor(black) legend("SEP-consistent baseline") lwidth(2)
fig1b.addtext(t,just(c),font("arial",18)) 10-Year Treasury Yield


smpl %graphstart %graphend
graph fig1c.line lur{%sufcontrol} lur
fig1c.options size(7,4.2)
fig1c.legend display -inbox position(3.9,0.3) font("arial",15)
fig1c.datelabel format(yy)
fig1c.addtext(6.4,-.30,font("arial",13),keep) percent
fig1c.axis(left) font("arial",15)
fig1c.axis(bottom) font("arial",15)
fig1c.setelem(1) lcolor(red)  legend("optimal control") lwidth(2)
fig1c.setelem(2) lcolor(black) legend("SEP-consistent baseline") lwidth(2)
fig1c.addtext(t,just(c),font("arial",18)) Unemployment Rate


smpl %graphstart %graphend
graph fig1d.line pic4{%sufcontrol} pic4
fig1d.options size(7,4.2)
fig1d.legend display -inbox position(0.5,0.2) font("arial",15)
fig1d.datelabel format(yy)
fig1d.addtext(6.4,-.30,font("arial",13),keep) percent
fig1d.axis(left) font("arial",15)
fig1d.axis(bottom) font("arial",15)
fig1d.setelem(1) lcolor(red)  legend("optimal control") lwidth(2)
fig1d.setelem(2) lcolor(black) legend("SEP-consistent baseline") lwidth(2)
fig1d.addtext(t,just(c),font("arial",18)) PCE Inflation Rate (4-Quarter)
```

```
graph fig1.merge fig1a fig1b fig1c fig1d
if %mcvars_wp = "no" and %mcvars_all = "no" then
  %title = "Macroeconomic Effects of Optimal-Control Policy with Rational Expectati
  endif
if %mcvars_wp = "yes" and %mcvars_all = "no" then
  %title = "Macroeconomic Effects of Optimal-Control Policy\n With Rational Expecta
  endif
if %mcvars_all = "yes" then
  %title = "Macroeconomic Effects of Optimal-Control Policy With Full Rational Expe
  endif

if %zerobound = "yes" then
  %title = %title + "\rZLB Imposed"
  else
  %title = %title + "\rZLB not Imposed"
  endif

fig1.addtext(t,just(c),font("Arial",20)) {%title}
fig1.align(2,1,1.25)
show fig1
```

Defines:
ocpolicy, used in chunk 168.
Uses dateshift 79, group2zero 81a, groupnew 82, make_frbus_mcevars 164, mce_load_frbus 160, mce_run 88, mce_solve_library 210 215a, set_fp 84, and set_mp 85a.

2.6 pings program

31 ⟨*simulate six ping simulations, aka simple IRFs* 31⟩≡ (187d)

```
' Simulate six ping simulations (AKA simple IRFs)
'
' Notes:
'
' 1. Choose between VAR expectations and several MCE alternatives
' with the %mcevars parameter.
'
'   - %mcevars = "none"   => VAR expectations everywhere
'   - %mcevars = "mcap"   => MCE in asset pricing, VAR expectations elsewhere
'   - %mcevars = "mcapwp" => MCE in asset pricing and price-wage setting;
'        VAR expectations elsewhere
'   - %mcevars = "all"    => MCE everywhere
'
' Note that even when %mcevars = "none", the program does many
' of the setup steps for an MCE simulation even though it never
' uses what they create.

' 2. Seven of the pings are one-time shocks to the residual of an
' equation whose structure contains a large autoregressive
' element.  The remaining ping involves a permanent increase in the
' level of trend MFP.

' 3. The eight pings are:
'
'   - A 100 basis point upward shock to the rffintay monetary
'     policy rule
'   - An increase in federal purchases equal to one percent of
'     baseline GDP
'   - A one percent permanent increase in the level of trend MPF
'   - A 100 bp increase in the equity premium
'   - A $10 per barrel increase in the price of oil
'   - A 1 percent (ar) increase in the growth rate of
'     multifactor productivity
'   - Increases of 100 basis points to the 10-year Treasury term premium,
'     75 basis points to the 5-year premium, and 30 basis points to the
'     30-year premium
'   - A 10 percent increase in the (real) exchange rate

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
```

```
include ../subs/master_library
include ../subs/mce_solve_library

' Workfile
%wfstart = "1975q1"
%wfend = "2100q4"
%mainpage = "main"
wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model names and locations
%varmod = "stdver"
%varpath = "../mods/"
%mcemod = "pfver"
%mcepath = "../mods/"

' Input datbase
%dbin  = "../data/longbase"

' Simulation range
%simstart = "2020q1"
%simend   = "2069q4"

' Choose an expectations option ("none" => VAR expectations, "mcap", "mcapwp", "all")
%mcevars = "none"

' ******************************************************************
' Retrieve data, model equations and coefficients, set
' policy options, and compute tracking residuals
' ******************************************************************

' MCE variable setup
if %mcevars = "none" then
  %zvars = "zpic58 "
  else
  %zvars = "zdivgr zgap05 zgap10 zgap30 zrff5 zrff10 zrff30 zpi10 zpi10f zpic30 zpi
  if %mcevars = "mcapwp" or %mcevars = "all" then
    %zvars = %zvars + "zpicxfe zpieci "
    endif
  if %mcevars = "all" then
    %zvars = %zvars + "zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvpi zvps zxbd zxbi zxbs
    endif
  endif

' Load equations and coefficients
call mce_load_frbus("mce_vars=%zvars,mod_b=%varmod,path_b=%varpath,mod_f=%mcemod,pa
```

```
' Load data
dbopen %dbin as longdata
fetch(d=longdata) *

' Data for extra variables associated with MC expectations
smpl @all
call make_frbus_mcevars(%zvars)

' Set monetary policy
smpl @all
call set_mp("dmpintay")

' Turn off zero bound and policy thresholds; hold policymaker's
' perceived equilibrium real interest rate constant
smpl @all
dmptrsh = 0
rffmin = -9999
drstar = 0

' Set fiscal policy
smpl @all
call set_fp("dfpsrp")

' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
call group2zero("endog_aerr")

' Standard solution options
{%varmod}.solveopt(o=b,g=12,z=1e-12)
{%mcemod}.solveopt(o=b,g=12,z=1e-12)

' Assign baseline tracking add factors
%suftrk = "_0"
smpl %simstart %simend
{%varmod}.addassign @all
{%varmod}.addinit(v=n) @all
{%varmod}.scenario(n,a={%suftrk}) "track"
{%varmod}.solve
scalar mm = @max(@abs(xgap{%suftrk}-xgap))
if mm > .0001 then
  statusline dynamic tracking simulation failed for {%varmod}
  stop
  endif
{%mcemod}.addassign @all
```

```
  {%mcemod}.addinit(v=n) @all




' ********************************************************************
' Ping simulations
' ********************************************************************

  %suf = "_1"
  {%varmod}.scenario(n,a={%suf}) "ping"
  {%mcemod}.scenario(n,a={%suf}) "ping"

' *********************************
' Federal Funds Rate: RFF ping

  %ping = "rff"

  smpl %simstart %simstart
  rffintay_aerr = rffintay_aerr + 1
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  rffintay_aerr = rffintay_aerr - 1
  call copyit

' *********************************
' Treasury Term Premium: RG10P, RG5P, and RG30P ping

  %ping = "prem"
  smpl @all
  series rg30p_aerr = 0
  smpl %simstart %simstart
  rg10p_aerr = rg10p_aerr + 1
  rg5p_aerr = rg5p_aerr + .75
  rg30p_aerr = rg30p_aerr + .35
  smpl %simstart %simend
  if %mcevars = "none" then
```

```
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  rg10p_aerr = rg10p_aerr - 1
  rg5p_aerr = rg5p_aerr - 0.75
  rg30p_aerr = rg30p_aerr - .35
  call copyit
  smpl %simstart %simend
  series rg10p_{%ping} = rg10p{%suf} - rg10p

' *********************************
' Federal Purchases: EGFO ping

  %ping = "eg"
  smpl %simstart %simstart
  egfo_aerr = egfo_aerr + .01*xgdpn/egfon
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  egfo_aerr = egfo_aerr - .01*xgdpn/egfon
  call copyit
  smpl %simstart %simend
  series egfn_shr_{%ping} = 100*(egfn{%suf}/xgdpn{%suf} - egfn/xgdpn)

' *********************************
' Equity Premium: REQP ping

  %ping = "reqp"
  smpl %simstart %simstart
  reqp_aerr = reqp_aerr + 1
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
```

```
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  reqp_aerr = reqp_aerr - 1
  call copyit
  smpl %simstart %simend
  series reqp_{%ping} = reqp{%suf} - reqp


' *********************************
' Oil Prices: POILR ping

  %ping = "oil"
  smpl %simstart %simstart
  poilr_aerr = poilr_aerr + 10/pxb
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  poilr_aerr = poilr_aerr - 10/pxb
  call copyit
  smpl %simstart %simend
  series poil_{%ping} = poil{%suf} - poil



' *********************************
' Exchange Rate: FPXRR ping

  %ping = "exch"
  smpl %simstart %simstart
  series shock_fpxr = log(1.1)
  fpxrr_aerr = fpxrr_aerr + shock_fpxr

  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
```

```
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif

  series fpxr_{%ping} = fpxr{%suf} - fpxr
  smpl %simstart %simstart
  fpxrr_aerr = fpxrr_aerr - shock_fpxr
  call copyit


' *********************************
' HMFPT ping

  %ping = "hmfp"
  smpl %simstart %simstart
  hmfpt_aerr = hmfpt_aerr + 1
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  hmfpt_aerr = hmfpt_aerr - 1
  call copyit
  smpl %simstart %simend
  series hmfpt_{%ping} = hmfpt{%suf} - hmfpt


' *********************************
' MFPT ping

  %ping = "mfp"
  smpl %simstart %simstart
  mfpt_aerr = mfpt_aerr + .01
  smpl %simstart %simend
  if %mcevars = "none" then
    {%varmod}.solve
    else
    %modstr = "mod_b=%varmod,mod_f=%mcemod,mce_vars=%zvars"
```

```
    %algstr = "meth=qnewton"
    %simstr = "type=single,solveopt=%sopt,suf=" + %suf
    call mce_run(%modstr,%algstr,%simstr)
    endif
  smpl %simstart %simstart
  mfpt_aerr = mfpt_aerr - .01
  call copyit
  smpl %simstart %simend
  series mfpt_{%ping} = 100*(mfpt{%suf}/mfpt - 1)


' ******************************************************************
' Individual ping graphs
' ******************************************************************
  call graphit


' ******************************************************************
' Composite figures
' ******************************************************************

  if %mcevars = "none" then
    %exp = "VAR Expectations"
    endif
  if %mcevars = "mcap" then
    %exp = "MC (MCAP) Expectations"
    endif
  if %mcevars = "mcapwp" then
    %exp = "MC (MCAP+WP) Expectations"
    endif
  if %mcevars = "all" then
    %exp = "MC (ALL) Expectations"
    endif

  %t1 = "FRB/US Ping Simulations:  " + %exp + " -- I"
  %t2 = "FRB/US Ping Simulations:  " + %exp + " -- II"
  %t3 = "FRB/US Ping Simulations:  " + %exp + " -- III"

' Figure 1

  graph fig_1.merge gr_rff gr_eg gr_reqp
  fig_1.align(3,.4,1.0)
  fig_1.addtext(t,just(c),font(12)) %t1
  show fig_1
```

```
' Figure 2

graph fig_2.merge gr_oil gr_hmfp gr_mfp
fig_2.align(3,.4,1.0)
fig_2.addtext(t,just(c),font(12)) %t2
show fig_2


' Figure 3

graph fig_3.merge gr_prem gr_exch
fig_3.align(3,.4,1.0)
fig_3.addtext(t,just(c),font(12)) %t3
show fig_3
```

Uses copyit 188a, graphit 189, group2zero 81a, groupnew 82, make_frbus_mcevars 164, mce_load_frbus 160, mce_run 88, mce_solve_library 210 215a, pings 187d, set_fp 84, and set_mp 85a.

Chapter 3

Model Consistent Expectation Solve Package

3.1 example1 program

41 ⟨*mce example1* 41⟩≡ (214a)

```
' This example illustrates:
'
'   - The automated approach to constructing the two operational
'     models
'   - How to define the multiplier shock in a text
'     file whose lines are executed from within the call to
'     mce_run
'   - How to declare the model scenario and the scenario
'     scenario alias within the call to mce_run
'   - The use of the "linear" option of the "newton" algorithm
'     for a linear model in which the maximum endogenous lead and
'     lag is one period

'************************************************************
'************************************************************
'************************************************************
' Section 1:  Workfile, model name, simulation range

  include  mce_solve_library

' Workfile
  %wfstart = "2000q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}
```

```
' Model name
  %mod = "simple"

' Simulation range
  %simstart = "2001q1"
  %simend = "2025q4"


'*************************************************************
'*************************************************************
'*************************************************************
' Section 2:  Model, coefficients, and data

' equations

  model {%mod}
  {%mod}.append pinf = cp(1) * pinf(-1) + (.98-cp(1))*pinf(1)+ cp(2) * ygap
  {%mod}.append rate = cr(1)*rate(-1)+(1-cr(1))*(cr(2)*pinf + cr(3)*ygap)
  {%mod}.append ygap = cy(1) * ygap(-1) + (.98-cy(1))*ygap(1) + cy(2) * (rate - pinf(


' coefficients

  coef(2) cy
  cy.fill .50, -.02
  coef(2) cp
  cp.fill .50, .02
  coef(3) cr
  cr.fill .75, 1.5, 0.5

' set all data to zero
  smpl @all
  %vars = {%mod}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
    series {%tmp} = 0
    next


'*************************************************************
'*************************************************************
'*************************************************************
' Section 3: Simulation

  text shock1
```

```
shock1.append smpl {%simstart} {%simstart}
shock1.append series rate_a = rate_a + 1

%mopts = "create,mod=%mod,adds,track"
%aopts = "jinit=linear"
%sopts = "type=single,txt=shock1,scen,suf=_1"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)
copy mce_sim_spool mce_sim_spool_1
show mce_sim_spool_1

series zero = 0
smpl %simstart %simstart + 39
graph gr1.line zero rate_1 pinf_1 ygap_1
gr1.addtext(t,c,font(14)) "Positive interest rate shock"
show gr1
```

Defines:
example1, used in chunk 168.
Uses mce_run 88 and mce_solve_library 210 215a.

3.2 example2 program

44 ⟨*mce example2* 44⟩≡ (214b)

```
' This example illustrates:
'
'   - A manual approach to constructing the two operational
'     models that mimics what the automated approach does
'   - How to define the multiplier shock in a text
'     file whose lines are executed from within the call to
'     mce_run
'   - How to declare the model scenario and the scenario
'     scenario alias within the call to mce_run
'   - The use of the "linear" option of the "newton" algorithm
'     for a linear model in which the maximum endogenous lead and
'     lag is one period

'*************************************************************
'*************************************************************
'*************************************************************
' Section 1:  Workfile, model name, simulation range

  include  mce_solve_library

' Workfile
  %wfstart = "2000q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' Model names
  %modb = "simpleb"
  %modf = "simplef"

' Simulation range
  %simstart = "2001q1"
  %simend = "2025q4"


'*************************************************************
'*************************************************************
'*************************************************************
' Section 2:  Model, coefficients, and data

' equations in backward-looking model

  model {%modb}
```

```
  {%modb}.append pinf = cp(1) * pinf(-1) + (.98-cp(1))*zpinf+ cp(2) * ygap
  {%modb}.append rate = cr(1)*rate(-1)+(1-cr(1))*(cr(2)*pinf + cr(3)*ygap)
  {%modb}.append ygap = cy(1) * ygap(-1) + (.98-cy(1))*zygap + cy(2) * (rate - zpinf)

' equations in expectations errors model

  model {%modf}
  {%modf}.append ezpinf = zpinf - pinf(1)
  {%modf}.append ezygap = zygap - ygap(1)

' coefficients

  coef(2) cy
  cy.fill .50, -.02
  coef(2) cp
  cp.fill .50, .02
  coef(3) cr
  cr.fill .75, 1.5, 0.5

' set all data to zero
  smpl @all
  %vars = {%modb}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
    series {%tmp} = 0
    next
  %vars = {%modf}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
    series {%tmp} = 0
    next

' declare mce variables and instruments
  %instrus = "zpinf zygap"
  %errs = "ezpinf ezygap"

'************************************************************
'************************************************************
'************************************************************
' Section 3: Simulation


  text shock1
  shock1.append smpl {%simstart} {%simstart}
  shock1.append series rate_a = rate_a + 1
```

```
%mopts = "mod_b=%modb,mod_f=%modf,mce_instrus=%instrus,mce_errs=%errs,adds,track"
%aopts = "jinit=linear"
%sopts = "type=single,txt=shock1,scen,suf=_1"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)
copy mce_sim_spool mce_sim_spool_1
show mce_sim_spool_1

series zero = 0
smpl %simstart %simstart + 39
graph gr1.line zero rate_1 pinf_1 ygap_1
gr1.addtext(t,c,font(14)) "Positive interest rate shock"
show gr1
```

Defines:
example2, used in chunk 168.
Uses mce_run 88 and mce_solve_library 210 215a.

3.3 example3 program

47 ⟨*mce example3* 47⟩≡ (214c)

```
' This example illustrates:
'
'   - Another manual approach to constructing the two operational
'     models that introduces new endogenous variables for the
'     expectations leads along with simple equations for the new
'     endogenous variables.
'   - The MCE instruments are the add factors on the equations for
'     the new endogenous variables; this circumstance requires that
'     add factors be assigned to the operational models prior to
'     the call to mce_run.
'   - The option of defining the multiplier shock in commands that
'     are executed prior to the call to mce_run, when the manual
'     approach is used.
'   - The option of declaring model scenarios and the scenario
'     scenario alias prior to the call to mce_run, when the manual
'     approach is used.
'   - The model no longer satisfies the conditions for which the
'     "jinit=linear" option of the "newton" algorithm is designed.
'     This example uses "jinit=interp(4)" to specify a
'     particular approximate Jacobian.
'
'   - This example runs three simulations.  In the second and third
'     simulations, the assignment of null strings to the first two
'     arguments of the mce_run subroutine causes the simulations to be
'     run with the same internal models and algorithm (including
'     the Newton MCE Jacobian) that were created or declared in the
'     first simulation.

'*************************************************************
'*************************************************************
'*************************************************************
' Section 1:  Workfile, model name, simulation range

  include  mce_solve_library

' Workfile
  %wfstart = "2000q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' Model names
  %modb = "simpleb"
```

```
  %modf = "simplef"

' Simulation range
  %simstart = "2001q1"
  %simend = "2025q4"


'*************************************************************
'*************************************************************
'*************************************************************
' Section 2:  Model, coefficients, and data

' equations in backward-looking model

  model {%modb}
  {%modb}.append pinf = cp(1) * pinf(-1) + (.98-cp(1))*zpinf+ cp(2) * ygap
  {%modb}.append rate = cr(1)*rate(-1)+(1-cr(1))*(cr(2)*pinf + cr(3)*ygap)
  {%modb}.append ygap = cy(1) * ygap(-1) + (.98-cy(1))*zygap + cy(2) * (rate - zpinf)
  {%modb}.append zpinf = @movav(pinf(-1),4)
  {%modb}.append zygap = @movav(ygap(-1),4)

' equations in expectations errors model

  model {%modf}
  {%modf}.append ezpinf = zpinf - pinf(1)
  {%modf}.append ezygap = zygap - ygap(1)

' coefficients

  coef(2) cy
  cy.fill .50, -.02
  coef(2) cp
  cp.fill .50, .02
  coef(3) cr
  cr.fill .75, 1.5, 0.5

' set all data to zero
  smpl @all
  %vars = {%modb}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
    series {%tmp} = 0
    next
  %vars = {%modf}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
```

```
      series {%tmp} = 0
      next

  ' declare mce variables and instruments
    %instrus = "zpinf_a zygap_a"
    %errs = "ezpinf ezygap"

  ' assign tracking add factors
    smpl %simstart %simend
    {%modb}.addassign @all
    {%modb}.addinit(v=n) @all
    {%modf}.addassign @all
    {%modf}.addinit(v=n) @all

  '*************************************************************
  '*************************************************************
  '*************************************************************
  ' Section 3: Simulations

    %sufm = "_1"
    {%modb}.scenario(n,a=%sufm) "multiplier"
    {%modf}.scenario(n,a=%sufm) "multiplier"


  ' Sim 1:  interest rate shock

    smpl {%simstart} {%simstart}
    rate_a = rate_a + 1

    %mopts = "mod_b=%modb,mod_f=%modf,mce_instrus=%instrus,mce_errs=%errs"
    %aopts = "jinit=interp(4)"
    %sopts = "type=single"
    smpl {%simstart} {%simend}
    call mce_run(%mopts,%aopts,%sopts)
    smpl {%simstart} {%simstart}
    rate_a = rate_a - 1

    series zero = 0
    smpl %simstart %simstart + 39
    graph gr1.line zero rate{%sufm} pinf{%sufm} ygap{%sufm}
    gr1.addtext(t,c,font(14)) "Positive interest rate shock"
    show gr1


  ' Sim 2:  output gap shock
```

```
smpl {%simstart} {%simstart}
ygap_a = ygap_a + 1

%mopts = ""
%aopts = ""
%sopts = "type=single"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)
smpl {%simstart} {%simstart}
ygap_a = ygap_a - 1

series zero = 0
smpl %simstart %simstart + 39
graph gr2.line zero rate{%sufm} pinf{%sufm} ygap{%sufm}
gr2.addtext(t,c,font(14)) "Positive output gap shock"
show gr2

' Sim 3:  inflation shock

smpl {%simstart} {%simstart}
pinf_a = pinf_a + 1

%mopts = ""
%aopts = ""
%sopts = "type=single"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)
smpl {%simstart} {%simstart}
pinf_a = pinf_a - 1

series zero = 0
smpl %simstart %simstart + 39
graph gr3.line zero rate{%sufm} pinf{%sufm} ygap{%sufm}
gr3.addtext(t,c,font(14)) "Positive inflation shock"
show gr3
```

Defines:
example3, used in chunk 168.
Uses mce_run 88 and mce_solve_library 210 215a.

3.4 example4 program

51 ⟨*mce example4* 51⟩≡ (214d)

```
' This example illustrates:
'
'   - The simulation of a nonlinear model (zero bound imposed)
'     (because the baseline data is set to zero; the zero-bound
'     is set illustratively to -1)
'   - The use of the qnewton algorithm

'************************************************************
'************************************************************
'************************************************************
' Section 1:  Workfile, model name, simulation range

  include  mce_solve_library

' Workfile
  %wfstart = "2000q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' Model names
  %modb = "simpleb"
  %modf = "simplef"

' Simulation range
  %simstart = "2001q1"
  %simend = "2025q4"


'************************************************************
'************************************************************
'************************************************************
' Section 2:  Model, coefficients, and data

' equations in backward-looking model

  model {%modb}
  {%modb}.append pinf = cp(1) * pinf(-1) + (.98-cp(1))*zpinf+ cp(2) * ygap
  {%modb}.append rate_u = cr(1)*rate(-1)+(1-cr(1))*(cr(2)*pinf + cr(3)*ygap)
  {%modb}.append rate = @recode( rate_u>rate_min,rate_u,rate_min)
  {%modb}.append ygap = cy(1) * ygap(-1) + (.98-cy(1))*zygap + cy(2) * (rate - zpinf)
  {%modb}.append zpinf = @movav(pinf(-1),4)
  {%modb}.append zygap = @movav(ygap(-1),4)
```

```
' equations in expectations errors model

model {%modf}
{%modf}.append ezpinf = zpinf - pinf(1)
{%modf}.append ezygap = zygap - ygap(1)

' coefficients

coef(2) cy
cy.fill .50, -.02
coef(2) cp
cp.fill .50, .02
coef(3) cr
cr.fill .75, 1.5, 0.5

' set all data to zero
smpl @all
%vars = {%modb}.@varlist
for !i = 1 to @wcount(%vars)
  %tmp = @word(%vars,!i)
  series {%tmp} = 0
  next
%vars = {%modf}.@varlist
for !i = 1 to @wcount(%vars)
  %tmp = @word(%vars,!i)
  series {%tmp} = 0
  next

' declare mce variables and instruments
%instrus = "zpinf_a zygap_a"
%errs = "ezpinf ezygap"

' assign tracking add factors
smpl %simstart %simend
{%modb}.addassign @all
{%modb}.addinit(v=n) @all
{%modf}.addassign @all
{%modf}.addinit(v=n) @all

'*************************************************************
'*************************************************************
'*************************************************************
' Section 3: Simulation

%zb = "yes"
```

```
%sufm = "_1"
{%modb}.scenario(n,a=%sufm) "multiplier"
{%modf}.scenario(n,a=%sufm) "multiplier"

if %zb = "yes" then
  smpl @all
  rate_min = -1
  else
  rate_min = -9999
  endif

smpl {%simstart} {%simstart}
ygap_a = ygap_a - 5

%mopts = "mod_b=%modb,mod_f=%modf,mce_instrus=%instrus,mce_errs=%errs"
%aopts = "meth=qnewton"
%sopts = "type=single"
smpl {%simstart} {%simend}
tic
call mce_run(%mopts,%aopts,%sopts)
scalar elapsed = @toc
show elapsed

series zero = 0
smpl %simstart %simstart + 39
graph gr1.line zero rate{%sufm} pinf{%sufm} ygap{%sufm}
%title = "Negative Output Shock"
if %zb = "yes" then
  %title = %title + "\r(zero bound imposed)"
  else
  %title = %title + "\r(zero bound not imposed)"
  endif
gr1.addtext(t,c,font(14)) %title
show gr1
```

Defines:
example4, used in chunk 168.
Uses mce_run 88 and mce_solve_library 210 215a.

3.5 example5 program

54 ⟨*mce example5* 54⟩≡ (214e)

```
' This example illustrates the two optimal policy simulation types
'
'   - Simulate the effects of a positive shock to the output gap
'     using sequentially
'
'     (a) the model's interest rate rule
'
'     (b) the opt simulation type to find the optimal interest rate
'     path under commitment
'
'     (c) the opttc simulation type to find the optimal time-consistent
'     or discretionary interest rate path; note that the solution in
'     this case is only approximate
'
'     In both (b) and (c) the policy instrument is the residual of
'     the interest rule
'
'   - The illustrative loss function penalizes equally weighted,
'     discounted, squared deviations of the output gap,
'     inflation, and the first difference of the interest rate.
'

'************************************************************
'************************************************************
'************************************************************
' Section 1:  Workfile, model name, simulation range

  include  mce_solve_library

' Workfile
  %wfstart = "2000q1"
  %wfend = "2100q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' Model name
  %mod = "simple"

' Simulation range
  %simstart = "2001q1"
  %simend = "2025q4"

'************************************************************
```

```
'************************************************************
'************************************************************
' Section 2:  Model, coefficients, and data

' equations

  model {%mod}
  {%mod}.append pinf = cp(1) * pinf(-1) + (.98-cp(1))*pinf(1)+ cp(2) * ygap
  {%mod}.append rate - rate_aerr = cr(1)*rate(-1)+(1-cr(1))*(cr(2)*pinf + cr(3)*ygap)
  {%mod}.append ygap = cy(1) * ygap(-1) + (.98-cy(1))*ygap(1) + cy(2) * (rate - pinf(1))
  {%mod}.append drate = rate - rate(-1)


' coefficients

  coef(2) cy
  cy.fill .50, -.02
  coef(2) cp
  cp.fill .50, .02
  coef(3) cr
  cr.fill .75, 1.5, 0.5

' set all data to zero
  smpl @all
  %vars = {%mod}.@varlist
  for !i = 1 to @wcount(%vars)
    %tmp = @word(%vars,!i)
    series {%tmp} = 0
    next

'************************************************************
'************************************************************
'************************************************************
' Section 3: Optimal policy setup

' targets, instruments
  group opt_instrus rate_aerr
  group opt_targs pinf ygap drate

' desired target trajectories
  smpl @all
  series pinf_t = 0
  series ygap_t = 0
  series drate_t = 0

' loss function weights
```

```
%discount = ".99"
%y_weight = "1.0"
%p_weight = "1.0"
%r_weight = "1.0"
smpl @all
series ygap_w = @val(%y_weight)
series pinf_w =  @val(%p_weight)
series drate_w  =  @val(%r_weight)
!discount = @val(%discount)
smpl %simstart+1 %simend
ygap_w = !discount * ygap_w(-1)
pinf_w = !discount * pinf_w(-1)
drate_w = !discount * drate_w(-1)


'*************************************************************
'*************************************************************
'*************************************************************
' Section 3: Simulations

text shock1
shock1.append smpl {%simstart} {%simstart}
shock1.append series ygap_a = ygap_a + 3

' run the simulation using the monetary policy rule

%mopts = "create,mod=%mod,adds,track"
%aopts = "jinit=linear"
%sopts = "type= single,txt=shock1,scen,suf=_1"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)

smpl @all
series rate_rule = rate_1
series pinf_rule = pinf_1
series ygap_rule = ygap_1


' run the simulation using opt

%mopts = ""
%aopts = ""
%sopts = "type=opt,instrus=opt_instrus,targs=opt_targs"
smpl {%simstart} {%simend}
call mce_run(%mopts,%aopts,%sopts)
```

```
    smpl @all
    series rate_opt = rate_1
    series pinf_opt = pinf_1
    series ygap_opt = ygap_1


  ' run the simulation using opttc

    %mopts = ""
    %aopts = ""
    %sopts = "type=opttc,instrus=opt_instrus,targs=opt_targs"
    smpl {%simstart} {%simend}
    call mce_run(%mopts,%aopts,%sopts)

    smpl @all
    series rate_opttc = rate_1
    series pinf_opttc = pinf_1
    series ygap_opttc = ygap_1

  'graph

    smpl %simstart %simstart + 39
    series zero = 0
    graph gr1.line zero rate_rule rate_opt rate_opttc
    graph gr2.line zero pinf_rule pinf_opt pinf_opttc
    graph gr3.line zero ygap_rule ygap_opt ygap_opttc
    graph gr4.merge gr1 gr2 gr3
    %title = "Effects of Positive Output Shock Under Three Policy Responses"
    %title = %title + "\r1.  An intertial interest rate rule (_rule)"
    %title = %title + "\r2.  Optimal policy under committment (_opt)"
    %title = %title + "\r3.  Optimal time-consistent policy (_opttc)"
    gr4.addtext(t,c,font(14)) %title
    show gr4
```

Defines:
  example5, used in chunk 168.
Uses mce_run 88 and mce_solve_library 210 215a.

Chapter 4

State Space Package

4.1 Estimate Model

59 ⟨*estimation model* 59⟩≡ (215d)

```
' Program to estimate the FRB/US state-space model and
' generate estimates of model states.


' Subroutines:
'    To transform data
include "./data_transformations"

'    To estimate the model
include "./estimation_code"
include "./initial_values"

close @all
wfcreate kf_data q 1949:1 2020:4

%estend    = "2013q4"
%eststart  = "1963q2"
%datastart = "1949q1"



sample estsample  %eststart  %estend
sample datasample %datastart %estend
%datasmpl = %datastart + " " + %estend
%modname = "ss_model"
```

```
'*******************************************************************************
' Retrieve variables from the database

' Definitions of series in database
'    See FRB/US model documentation for more complete descriptions

' XGDP   - GDP, cw 2009$
' XGDPN  - GDP
' XB   - BLS Business output, 2009$
' XBN  - BLS Business output
' XGDIN  - GDI

' PGDP   - Price index for GDP, cw
' PXB  - BLS Business price

' LEP    - Employment in business sector (employee and self-employed)
' LHP    - Aggregate labor hours, business sector (employee and self-employed)
' LUR    - Civilian unemployment rate (break adjusted)
' LF     - Civilian labor force (break adjusted)
' N16    - Noninstitutional population, aged 16 and over (break adjusted)

' KS     - Capital services, 2009 $
' LQUALT - Labor quality, trend level
' VEOA   - Average energy-output ratio of existing capital stock

' PCXFE  - Price index for personal consumption expendits ex. food and energy, cw (NI
' PCER   - Price index for personal consumption expenditures on energy (relative to P

' PMO    - Price index for imports ex. petroleum, cw
' UCES   - Energy share of nominal consumption expenditures
' EMON   - Imports of goods and services ex. petroleum
' XGDEN  - Nominal Absorption
' PTR    - 10-year expected inflation (Hoey/Philadelphia survey)


%dbin = "state_space_data"
dbopen %dbin as dbin

string varlist = " xgdpn xbn pgdp pxb pcxfe pcer xgdp xb lep uces emon xgden ptr "
varlist = varlist + " ks lqualt veoa lhp lur lf n16 pmo xgdin "

fetch(d=dbin) {varlist}



'************************************************
```

```
' Make model observable series, set priors

smpl datasample

call data_transformations

'************************************************
' Specify and estimate model, save for re-use

smpl estsample

statusline Estimating model
call ss_estimation

{%modname}.makefilter saved_results



'************************************************************
' Create states

{%modname}.makestates(t=pred) *_prs        ' one-step ahead state predictions
{%modname}.makestates(t=filt) *_1          ' filter states
{%modname}.makestates(t=smooth) *_2        ' smoothed states
{%modname}.makestates(t=disturb) *err      ' estimate of the disturbances
{%modname}.makestates(t=filtse) *se        ' RMSE of the filtered states
{%modname}.makestates(t=smoothse) *se2     ' RMSE of the smoothed states

{%modname}.makesignals(t=pred) *_pr        ' one-step ahead signal predictions
{%modname}.makesignals(t=resid) *_res      ' error in one-step ahead signal predictions
{%modname}.makesignals(t=stdresid) *_sres  ' standardized one-step ahead prediction residual


'************************************************************
' Transformation into FRB/US mnemonics

series xbt  = exp((tmfp_2/.965 + 0.725*(terate_2 + tlfpr_2  + thtfactor_2 + tww_2) + _
                0.275*lks + 0.725*llqualt + (.035/.965)*lveoa +lpop)/100)
series hmfpt  = gtmfp_2
series qlfpr  = exp(tlfpr_2/100)
series hqlfpr = (gtlfpr_2/400)*qlfpr(-1)
series hqlww  = gtww_2
series huxb   = gtotfactor_2
series leppot = exp((tlfpr_2+terate_2+thtfactor_2)/100) * n16
series lurnat = 100*(1-exp(terate_2/100))
series qlww   = exp(tww_2/100)
```

```
series uxbt   = exp(totfactor_2/100)
series xgdpt  = xbt * uxbt
series xgdo   = exp(cycle_2/100)*xgdpt


wfsave saved_results_new
```

Defines:
frbus_supply_estimation, used in chunk 168.
saved_results_new, never used.
Uses data_transformations 63, estimation_code 66, initial_values 73, and ss_estimation 66.

4.2 Data Transformations

63 ⟨*data transformations* 63⟩≡ (215b)

```
subroutine data_transformations()

' Subroutine for FRB/US state-space model package to
' transform raw data from EViews database to observables
' used in the estimation of the state-space model.

' 1. Data transformations

series lpop = 100*log(n16)

'Business - product side
series nbp = xbn
series bp = log(xb)*100 -lpop

'GDP
series gdp = log(xgdp)*100 -lpop

'Buseness - income side
series dsnst_q = xgdpn - xgdin
series nbi = nbp - dsnst_q
series rbi = nbi/(pxb/100)
series bi = log(rbi)*100 -lpop

' Employment Business sector
series eb = log(lep)*100  - lpop

' Workweek
series hb = log(lhp)*100 - lpop
series bww = hb - eb

' Employment Rate
series erate = 100*log((100-lur)/100)

' Participation Rate
series lfpr = 100*log(lf/n16)

' Variables for TMFP:
series lks = 100*log(ks) - lpop
series llqualt = 100*log(lqualt)
series lveoa = 100*log(veoa)

' Series for the price equation
series c1pcex = @pca(pcxfe)
```

```
series engylag_pcex = 0.5*(uces(-1)+uces(-2))*@pca(pcer(-1))
series sw_coreimp_pcex = 0.5*((emon/xgden)+(emon(-1)/xgden(-1)))*@pca(pmo/pcxfe)
series dum84 = @year>=1985
series frzbulg = 0   ''' Nixon wage-price control programs
smpl 1971q3 1974q1
frzbulg = 1
smpl 1974q2 1974q4
frzbulg = -3.666



' For the output-sector ratio, we use the median unbiased approach of Stock
' and Watson (1998). Thus, tau_oti is the ratio of the variances of the level
' and drift shocks.

scalar tau_oti = .033260  ' modifier for the drift totfactor (OSR*) error term


'*******************************************************************************

' 2. Prior starting values for states.

'    For mean zero level states, set prior to zero.
'    For other level states, set prior to a data-based
'        value near the start of the sample.
'    For most drift terms, set prior to zero.
'        Exception is trend MFP, set equal to sample average.

' Cycle
scalar     icycle  =      0
scalar     icycle1 =      0
scalar     icycle2 =      0

' Measurement error
scalar     ie3p =         0
scalar     ie3i =         0

' Levels of trends
scalar     itotfactor =         @elem(gdp,%eststart) - @elem(bp,%eststart)
scalar     itmfp =             .965*(@elem(bp,%eststart) - 0.725*(@elem(eb,%eststart)
                                  + @elem(bww,%eststart))  - 0.275*@elem(lks,%eststa
                                  - 0.725*@elem(llqualt,%eststart) _
                                  - (.035/.965)*@elem(lveoa,%eststart))
scalar     itww =               @elem(bww,%eststart)
scalar     ithtfactor =         @elem(eb,%eststart) - @elem(erate,%eststart) _
                                - @elem(lfpr,%eststart)
```

```
scalar     itlfpr =             @elem(lfpr,%eststart)
scalar     iterate =            @elem(erate,%eststart)

' Initial drift terms
scalar     igtotfactor =        0.0
scalar     igtmfp =             1.7
scalar     igtww =              0.0
scalar     igthtfactor =        0.0
scalar     igtlfpr =            0.0

scalar nstate = 25

' The mpriors *must* be in the same order as the states are in the model object
vector(nstate) mpriors
mpriors.fill   0, ie3p, ie3i, 0, 0, _
               0, 0, icycle, icycle1, icycle2, _
               itotfactor, igtotfactor, itmfp, igtmfp, itww, _
               itww, igtww, ithtfactor, ithtfactor, igthtfactor, _
               itlfpr, itlfpr, igtlfpr, iterate, iterate


' Set starting values for variance priors
'     Variance priors set at a high value.  In estimation, variance
'     drops sharply in early periods of estimation sample.


sym(nstate) vpriors
for !d = 1 to nstate
   vpriors(!d, !d) = 3
   next

' A tighter prior for drift variances,
vpriors(12,12) = 1    ' igtotfactor
vpriors(14,14) = 1    ' igtmfp
vpriors(17,17) = 1    ' igtww
vpriors(20,20) = 1    ' igthtfactor

endsub
```

Defines:
data_transformations, used in chunks 59, 70, and 168.

4.3 Estimation Code

66 ⟨*estimation code* 66⟩≡ (215c)

```
subroutine ss_estimation()

' Subroutine for FRB/US state-space model package to
' estimate the model parameters.

'*******************************************************************************

' 1. Starting values for parameters.

' All of the coefficients in equations appear as beta or phi.
' Note that some values that are set here are hard coded in the estimation code belo

call initial_values

'*******************************************************************************
'  Model

sspace {%modname}  ' Declare a new state-space model object

' 2. Output equations.

' In the output equations, trend output is related to the capital stock, energy inte
' and trends for labor input using a production function.  The parameters of the pro
' function are hard-coded to the values in the FRB/US model.

' GDP observable
{%modname}.append @signal gdp = totfactor + tmfp/.965 + 0.725*(terate + tlfpr + thtf
                              + 0.275*lks + 0.725*llqualt + (.035/.965)*lveoa _
                              + cycle + beta(11)*beta(6) + beta(11)*e3p  + rexo
{%modname}.append @state rexo = [var=0.0000001^2]

' Buisines sector product-side observable
{%modname}.append @signal bp = tmfp/.965 + 0.725*(terate + tlfpr  + thtfactor + tww)
                              + 0.275*lks + 0.725*llqualt + (.035/.965)*lveoa  _
                              + beta(10)*cycle  +   beta(6) + e3p
{%modname}.append @state e3p =  beta(602)*e3p(-1) + re3p
{%modname}.append @ename re3p 'business prod error
{%modname}.append @evar var(re3p) =  (beta(125)^2)

' Business sector income-side observable
{%modname}.append @signal bi =  tmfp/.965  + 0.725*(terate + tlfpr  + thtfactor + tw
                              + 0.275*lks + 0.725*llqualt + (.035/.965)*lveoa _
                              + beta(10)*cycle - beta(6) + e3i
```

```
{%modname}.append @state e3i =   beta(602)*e3i(-1) + re3i
{%modname}.append @ename re3i 'business income error
{%modname}.append @evar var(re3i) =  (beta(126)^2)

' 3. Labor equations.

' Workweek observable
' To make this equation more consistent with the FRB/US workweek specification,
' a contemporaneous change in the cycle is included as well as the level of the
' cycle.  In addition, the coefficient on the lagged gap term in this equation is
' hard-coded at a value similar to that implicit in the FRB/US model.

{%modname}.append @signal bww =  tww _
             + phi(20)*(cycle-cycle1) _
             + phi(22)*cycle1 _
             + 0.82*(bww(-1)-tww1) _
             + eww
{%modname}.append @state eww =  [var=beta(104)^2]

' Employment observable
{%modname}.append @signal eb = terate + tlfpr + thtfactor + _
             + phi(30)*cycle _
             + phi(31)*(eb(-1)-(terate1 + tlfpr1 +thtfactor1)) _
             + eeb
{%modname}.append @state eeb = [var=beta(105)^2]

' Employment rate observable
{%modname}.append @signal erate = terate + phi(50)*cycle _
                     + phi(51)*(erate(-1)-terate1) _
                     + eerate
{%modname}.append @state eerate =  [var=beta(106)^2]

' Labor force participation observable
{%modname}.append @signal lfpr =  tlfpr + phi(40)*cycle _
                     + phi(41)*(lfpr(-1)-tlfpr1) _
                     + elfpr
{%modname}.append @state elfpr = [var=beta(107)^2]

' 4. Price observable
        {%modname}.append @ename ec
        {%modname}.append @evar var(ec) = (beta(109)^2)
          {%modname}.append @signal c1pcex = _
          beta(401)*c1pcex(-1) + (1-beta(401))*(ptr(-1)+.1) _
        + beta(404)*(((.50*cycle + .33*cycle1 + .17*cycle2 )) )  _
                + beta(405)*@movav(engylag_pcex(-1),6) _
                + beta(406)*@movav(dum84*engylag_pcex(-1),6)  _
```

```
        + beta(407)*frzbulg _
        + beta(408)*sw_coreimp_pcex + beta(409)*sw_coreimp_pcex(-1) _
        + ec

' 5. State equations

' Cycle state
{%modname}.append @state cycle = beta(1)*cycle(-1) + beta(2)*cycle1(-1) + ecycle
{%modname}.append @state cycle1 = cycle(-1)
{%modname}.append @state cycle2 = cycle1(-1)
{%modname}.append @ename ecycle
{%modname}.append @evar var(ecycle) = (beta(111)^2)

' Trends

'  Totfactor = OSR* in F.R.(2011)
'  tau_oti is taken from FR(2011)
{%modname}.append @state totfactor = totfactor(-1) + 0.25*.95*(gtotfactor(-1) ) + 0.2
                                     etotfactor + 0.25*egtotfactor
{%modname}.append @state gtotfactor = .95*gtotfactor(-1) + .05*beta(213) + egtotfacto
{%modname}.append @ename etotfactor
{%modname}.append @evar var(etotfactor) = (beta(112)^2)
{%modname}.append @ename egtotfactor
{%modname}.append @evar var(egtotfactor) = (4*((tau_oti))*beta(112))^2

' Multi-Factor Productivity (OPH*)
{%modname}.append @state tmfp = tmfp(-1) +  etmfp + 0.25*.95*(gtmfp(-1)) + 0.25*0.05*
{%modname}.append @state gtmfp = 0.95*gtmfp(-1) + 0.05*beta(214) + egtmfp
{%modname}.append @ename etmfp
{%modname}.append @evar var(etmfp) = beta(114)^2
{%modname}.append @ename egtmfp
{%modname}.append @evar var(egtmfp) = 0.14^2 ' beta(115)^2

'     For the workweek, employment-sector ratio, and LFPR, the level variances are ha
'     This hard-coding is done for convenience in production work.  In particular, th
'     values are close to the values these parameters take on when they are freely es
'     However, the t-ratios for these parameters are not very high, and that imprecis
'     to sluggish convergence; imposing these values shortens the time needed for est

' Workweek (WW*)
{%modname}.append @state tww = tww(-1) + 0.25*.95*(gtww(-1) ) +  etww + 0.25*.05*beta
{%modname}.append @state tww1 = tww(-1)
{%modname}.append @state gtww = .95*gtww(-1) + .05*beta(216) + egtww
{%modname}.append @ename etww
{%modname}.append @ename egtww
{%modname}.append @evar var(etww)  =  0.1^2
```

```
{%modname}.append @evar var(egtww) =  beta(117)^2

' Employment Sector Ratio (ESR*)
{%modname}.append @state thtfactor = thtfactor(-1) + 0.25*.95*gthtfactor(-1) + _
                                    0.25*egthtfactor + ethtfactor
{%modname}.append @state thtfactor1 = thtfactor(-1)
{%modname}.append @state gthtfactor = 0.95*gthtfactor(-1) + egthtfactor
{%modname}.append @ename ethtfactor
{%modname}.append @evar var(ethtfactor) = .01^2 ' beta(118)^2
{%modname}.append @ename egthtfactor
{%modname}.append @evar var(egthtfactor) = (beta(119)^2)

' Labor Force Participation (LFPR*)
{%modname}.append @state tlfpr = tlfpr(-1) + 0.25*(.95*gtlfpr(-1) + egtlfpr) +  etlfpr
{%modname}.append @state tlfpr1 = tlfpr(-1)
{%modname}.append @state gtlfpr = 0.95*gtlfpr(-1) + egtlfpr
{%modname}.append @ename etlfpr
{%modname}.append @evar var(etlfpr) = .05^2 ' beta(122)^2
{%modname}.append @ename egtlfpr
{%modname}.append @evar var(egtlfpr) = beta(123)^2

' Employment Rate (ER*), no drift
{%modname}.append @state terate = terate(-1) + eterate
{%modname}.append @state terate1 = terate(-1)
{%modname}.append @ename eterate
{%modname}.append @evar var(eterate) = beta(124)^2


{%modname}.append @vprior vpriors

{%modname}.append @mprior mpriors

freeze({%modname}_results) {%modname}.ml(m=100,showopts)

endsub
```

Defines:
estimation_code, used in chunks 59 and 168.
ss_estimation, used in chunk 59.
Uses initial_values 73.

4.4 Supply Filter

70 ⟨*supply filter* 70⟩≡ (215e)

```
' Program is part of the FRB/US state-space model package.
' frbus_supply_filter takes a previously estimated state-space model and
' generates estimates of model states.


' Subroutines:
'    To transform data
include "./data_transformations"


close @all
wfcreate kf_data q 1949:1 2020:4

%estend    = "2014q3"
%eststart  = "1963q2"
%datastart = "1949q1"

sample estsample  %eststart  %estend
sample datasample %datastart %estend

%modname = "ss_model"


'*******************************************************************************
' Retrieve variables from the database

' Definitions of series in database
'    See FRB/US model documentation for more complete descriptions

' XGDP   - GDP, cw 2009$
' XGDPN  - GDP
' XB   - BLS NFB output, 2009$
' XBN  - BLS NFB output
' XGDIN  - GDI

' PGDP   - Price index for GDP, cw
' PXB  - BLS NFB price

' LEP    - Employment in nonfarm business sector (employee and self-employed)
' LHP    - Aggregate labor hours, nonfarm business sector (employee and self-employed
' LUR    - Civilian unemployment rate (break adjusted)
' LF     - Civilian labor force (break adjusted)
' N16    - Noninstitutional population, aged 16 and over (break adjusted)
```

```
' KS     - Capital services, 2009 $
' LQUALT - Labor quality, trend level
' VEOA   - Average energy-output ratio of existing capital stock

' PCXFE  - Price index for personal consumption expendits ex. food and energy, cw (NIA def.)
' PCER   - Price index for personal consumption expenditures on energy (relative to PCXFE)

' PMO    - Price index for imports ex. petroleum, cw
' UCES   - Energy share of nominal consumption expenditures
' EMON   - Imports of goods and services ex. petroleum
' XGDEN  - Nominal Absorption
' PTR    - 10-year expected inflation (Hoey/Philadelphia survey)


smpl datasample
%dbin = "./state_space_data"
dbopen %dbin as histdata
fetch(d=histdata) *

'************************************************
' Make model observable series, set priors

smpl datasample

call data_transformations

'************************************************
' Load saved model; run estimation step with previously estimated
' parameters as starting values (converges quickly).

smpl estsample

wfopen saved_results
copy saved_results::untitled\saved_results kf_data::untitled\{%modname}
wfclose saved_results
freeze({%modname}_results) {%modname}.ml(m=100,showopts)


'************************************************************
' Create states

{%modname}.makestates(t=pred) *_prs        ' one-step ahead state predictions
{%modname}.makestates(t=filt) *_1          ' filter states
{%modname}.makestates(t=smooth) *_2        ' smoothed states
{%modname}.makestates(t=disturb) *err      ' estimate of the disturbances
```

```
{%modname}.makestates(t=filtse) *se        ' RMSE of the filtered states
{%modname}.makestates(t=smoothse) *se2     ' RMSE of the smoothed states

{%modname}.makesignals(t=pred) *_pr        ' one-step ahead signal predictions
{%modname}.makesignals(t=resid) *_res      ' error in one-step ahead signal predictio
{%modname}.makesignals(t=stdresid) *_sres  ' standardized one-step ahead prediction r


'*************************************************************
' Transformation into FRB/US mnemonics



series xbt  = exp((tmfp_2/.965 + 0.725*(terate_2 + tlfpr_2  + thtfactor_2 + tww_2) +
               0.275*lks + 0.725*llqualt + (.035/.965)*lveoa +lpop)/100)
series hmfpt  = gtmfp_2
series qlfpr  = exp(tlfpr_2/100)
series hqlfpr = (gtlfpr_2/400)*qlfpr(-1)
series hqlww  = gtww_2
series huxb   = gtotfactor_2
series leppot = exp((tlfpr_2+terate_2+thtfactor_2)/100) * n16
series lurnat = 100*(1-exp(terate_2/100))
series qlww   = exp(tww_2/100)
series uxbt   = exp(totfactor_2/100)
series xgdpt  = xbt * uxbt
series xgdo   = exp(cycle_2/100)*xgdpt
```

Defines:
  frbus.supply.filter, used in chunk 168.
Uses data_transformations 63.

4.5 Initial Values

73 ⟨*initial values* 73⟩≡ (215f)

```
subroutine initial_values


coef(703) beta
coef(60) phi
beta(1)          = 1.497516
beta(2)          = -0.540927
beta(213)        = -0.328852
beta(214)        = 1.061453
beta(216)        = -0.266658
beta(10)         = 1.325310
beta(401)        = 0.625693
beta(404)        = 0.090059
beta(405)        = 0.440360
beta(406)        = -0.324208
beta(407)        = -0.435237
beta(408)        = 0.293555
beta(409)        = 0.253904
beta(6)          = 0.331366
beta(602)        = 0.927692

phi(20)          = 0.301616
phi(22)          = 0.020651
phi(30)          = 0.452297
phi(31)          = 0.649965
phi(40)          = 0.042475
phi(41)          = 0.727876
phi(50)          = 0.299981
phi(51)          = 0.528947

beta(105)        = 0.176896
beta(106)        = 0.086226
beta(107)        = 0.210419
beta(104)        = 0.229143
beta(100)        = 0.000001
beta(109)        = 0.803236
beta(111)        = 0.566205
beta(119)        = 0.099423
beta(123)        = 0.129325
beta(115)        = 0.140001
beta(117)        = 0.081062
beta(124)        = 0.136532
beta(118)        = 0.010000
```

```
  beta(122)       = 0.050000
  beta(114)       = 0.107852
  beta(112)       = 0.044151
  beta(126)       = 0.476765
  beta(125)       = 0.534807
  beta(11) = 1/beta(10)


  endsub
```

Defines:
initial_values, used in chunks 59, 66, and 168.

Chapter 5

Data Only Package

Chapter 6

Appendices

Routine Libraries

6.1 Master Library

6.1.1 quarterly date string shift

79 ⟨*quarterly date string shift* 79⟩≡ (209b)

```
subroutine dateshift(string %indate, string %outdate, scalar qtrshift)

' this subroutine takes the quarterly date string in %indate (ie, "2001q1") and shifts
' it qtrshift quarters, returning the result in %outdate

  !dddd1   = @dateval(%indate,"yyyyfq")
  !dddd2   = @dateadd(!dddd1,qtrshift,"q")
  %outdate = @datestr(!dddd2,"yyyyfq")

  endsub
```

Defines:
`dateshift`, used in chunks 11, 23, 83, and 143.

6.1.2 copy series into group

80 ⟨*copy series into group* 80⟩≡ (209b)

```
subroutine group2group(string %fromgroup, string %togroup, string %to_type)

' copies a group of series into another group.
'
' If %to_type = "suffix", then %togroup is interpreted as a suffix to be applied to
' %fromgroup and its series.
'
' If %to_type = "prefix", then %togroup is interpreted as a prefix to be applied to
' %fromgroup and its series.
'
' If %to_type = "group", the %togroup is interpreted as the name of a group that
' already exists.

  if %to_type = "group" then
    if {%fromgroup}.@count <> {%togroup}.@count then
      statusline ERROR in GROUP2GROUP:  the two groups do not contain the same numbe
      endif
    for !ik1 = 1 to {%fromgroup}.@count
      %tmp = {%fromgroup}.@seriesname(!ik1)
      %tmp1 = {%togroup}.@seriesname(!ik1)
      {%tmp1} = {%tmp}
      next
    endif

  if %to_type = "suffix" then
    %tmpa = " "
    %tmpb = %fromgroup + %togroup
    for !ik1 = 1 to {%fromgroup}.@count
      %tmp = {%fromgroup}.@seriesname(!ik1) + %togroup
      %tmpa = %tmpa + " " + %tmp
      if @isobject(%tmp) then
        {%tmp} = {%fromgroup}(!ik1)
        else
        series {%tmp} = {%fromgroup}(!ik1)
        endif
      next
    group {%tmpb} {%tmpa}
    endif

  if %to_type = "prefix" then
    %tmpa = " "
    %tmpb = %togroup + %fromgroup
    for !ik1 = 1 to {%fromgroup}.@count
```

```
      %tmp =  %togroup + {%fromgroup}.@seriesname(!ik1)
      %tmpa = %tmpa + " " + %tmp
      if @isobject(%tmp) then
        {%tmp} = {%fromgroup}(!ik1)
        else
        series {%tmp} = {%fromgroup}(!ik1)
        endif
      next
    group {%tmpb} {%tmpa}
    endif

  endsub
```

Defines:
group2group, never used.

6.1.3 set group to zero

81a ⟨*set group to zero* 81a⟩≡ (209b)

```
  subroutine group2zero(string %group)

  ' set all series in an existin %group to zero

    for !ik1 = 1 to {%group}.@count
      %tmp = {%group}.@seriesname(!ik1)
      {%tmp} = 0
      next

  endsub
```

Defines:
group2zero, used in chunks 3, 7, 11, 17, 23, 31, 194, and 198.

6.1.4 names of all series in group

81b ⟨*names of all series in group* 81b⟩≡ (209b)

```
  subroutine groupnames2string(string %group, string %groupnames)

  ' creates a string of the names of all the series in a group

    %groupnames = " "
    for !ik1 = 1 to {%group}.@count
      %groupnames = %groupnames + " " + {%group}.@seriesname(!ik1)
      next

  endsub
```

Defines:
groupnames2string, used in chunk 198.

6.1.5 create new group

82 ⟨*create new group* 82⟩≡ (209b)

```
subroutine groupnew(string %fromgroup, string %to)

' Creates a new group.  The names of the new group and associated series are built up
' from %fromgroup with %to as a suffix.  Series that do not yet exist are set to zero

  %tmpa = " "
  %tmpb = %fromgroup + %to
  for !ik1 = 1 to {%fromgroup}.@count
    %tmp = {%fromgroup}.@seriesname(!ik1) + %to
    %tmpa = %tmpa + " " + %tmp
    if @isobject(%tmp) <> 1 then
      series {%tmp} = 0
      endif
    next
  group {%tmpb} {%tmpa}

endsub
```

Defines:
groupnew, used in chunks 3, 7, 11, 17, 23, 31, 194, and 198.

6.1.6 interpolate unavailable observations

83 ⟨*interpolate unavailable observations* 83⟩≡ (209b)

```
subroutine interp_lin(string %series_in, string %series_out, string %substart, string %subend)

' Subroutine that replaces NA values in a series with
' interpolated observations.  NA values at the beginning or end of the series are
' replaced with the first or last non-NA value.

smpl %substart %subend

' ******************************************************
' check that series is not all NAs
series tmp_check = ({%series_in} = NA)
if @sum(tmp_check) = @obssmpl then
  statusline Error in interp_lin subroutine:  interpolation cannot be performed because serie
  stop
  endif

series tmp_ser = ({%series_in}<>NA)
series tmp_id = @cumsum(tmp_ser)
series tmp_next = @sumsby({%series_in},tmp_id(-1))
series tmp_prev = @sumsby({%series_in},tmp_id)

' ******************************************************
' check for NAs at either beginning or end of sample

' test for NAs at beginning of sample
series tmp_naprev = (tmp_prev = NA)
!flag_prev = @max(tmp_naprev)
if !flag_prev = 1 then
  'at this point, tmp_next will have an undesired NA in its first observation;
  'change it to equal its second observation
  smpl %substart %substart
  call dateshift(%substart,%nextqtr,1)
  tmp_next = @elem(tmp_next,%nextqtr)
  smpl %substart %subend if (tmp_prev = NA)
  tmp_prev = tmp_next
  smpl %substart %subend
  endif

' test for NAs at end of sample
series tmp_nanext = (tmp_next = NA)
!flag_next = @max(tmp_nanext)
if !flag_next = 1 then
  smpl %substart %subend if (tmp_next = NA)
```

```
    tmp_next = tmp_prev
    smpl %substart %subend
    endif


  ' ***************************************************
  series tmp_lambda = (@obsid-@minsby(@obsid,tmp_id))/@sumsby(1,tmp_id)
  series {%series_out} = tmp_lambda*tmp_next + (1-tmp_lambda)*tmp_prev


  delete tmp_ser tmp_prev tmp_next tmp_lambda tmp_id tmp_nanext tmp_naprev tmp_check

endsub
```

Defines:
interp_lin, used in chunk 198.
Uses dateshift 79.

6.1.7 set fiscal policy option

84 ⟨*set fiscal policy option* 84⟩≡ (209b)

```
subroutine set_fp(string dfpxxx)

  %policy_options = "dfpex dfpsrp dfpdbt"
  %dfpxxx = @lower(dfpxxx)
  %dfpxxx = @replace(%dfpxxx," ","")

  !kz = @wfind(%policy_options,%dfpxxx)
  if !kz > 0 then
    for !izzz = 1 to @wcount(%policy_options)
      %ppp = @word(%policy_options,!izzz)
      if !izzz = !kz then
        series {%ppp} = 1
        else
        series {%ppp} = 0
        endif
      next
    else
    %err = %dfpxxx + " is not a valid fiscal policy option; execution terminated"
    @uiprompt(%err)
    stop
    endif

endsub
```

Defines:
set_fp, used in chunks 3, 7, 11, 17, 23, 31, and 198.

6.1.8 set monetary policy option

85a ⟨*set monetary policy option* 85a⟩≡ (209b)

```
subroutine set_mp(string dmpxxx)

  %policy_options = "dmpex dmprr dmptay dmptlr dmpintay dmpalt dmpgen"
  %dmpxxx = @lower(dmpxxx)
  %dmpxxx = @replace(%dmpxxx," ","")

  !kz = @wfind(%policy_options,%dmpxxx)
  if !kz > 0 then
    for !izzz = 1 to @wcount(%policy_options)
      %ppp = @word(%policy_options,!izzz)
      if !izzz = !kz then
        series {%ppp} = 1
        else
        series {%ppp} = 0
        endif
      next
    else
    %err = %dmpxxx + " is not a valid monetary policy option; execution terminated"
    @uiprompt(%err)
    stop
    endif

endsub
```

Defines:
set_mp, used in chunks 3, 7, 11, 17, 23, 31, and 198.

6.1.9 set monetary policy fed funds rate

85b ⟨*set monetary policy fed funds rate* 85b⟩≡ (209b)

```
subroutine set_mpvars2rff

  rfffix = rff
  rfftay = rffe
  rfftlr = rffe
  rffalt = rff
  rffintay = rffe
  rffgen = rffe
  rrfix = rffe - @movav(picxfe,4)

endsub
```

Defines:
set_mpvars2rff, never used.

6.2 mce solve library

6.2.1 mce solve library change history

86 ⟨*mce solve library change history* 86⟩≡ (211)

```
' Changes (1/25/14)
'
' 1.  Removed defaults from mce_load_frbus subroutine
'
' 2.  Added make_frbus_mcevars subroutine
'
' Changes (1/22/14)
'
' 1.  Added code so that the _$_sufsim string variable is assigned the
'     alias of the currently active scenario when the %mopts argument
'     is a null string.
'
' 2.  In subroutine mcz_sim, put the contents of string variable
'     mcz_sim_options into another string, a change which for unknown
'     reasons eliminates an unexplained Eviews shutdown when running
'     a pair of simulations of which the first is type=single and the
'     second is type=opt.

' Changes (1/8/14)
'
' 1.  Added the "dontstop" option to the %sopt argument.  When invoked,
'     this option causes the eviews program that calls mce_run
'     to continue executing when running a type=single simulation if
'     (a) the solution iterations do not
'     converge within the maximum number of permitted iterations or
'     (b) the eviews solver generates an error when solving either
'     the backward-looking or forward-looking models in subroutine
'     mcz_solvit.  In the case of nonconvergence the call to mce_run
'     terminates with the string value %mce_finish = "no".  In the
'     case of a solver error, the call to mce_run terminates with the
'     string value %mce_finish = "failed_solve".  Otherwise,
'     %mce_finish = "yes".
'
'
' Changes (2/21/12)
'
' 1. Fixed problem with code for unconstrained TC policy
'    calculated via EViews matrices -- the solution at period t
'    (t = 1, ... !ndrv) must go out through period
'    the farthest period ever solved -- (!nevl + !ndrv - 1) --
'    which requires that the opt derivative
```

```
'    matrix must span this many quarters.  The constrained TC
'
' 2. Wrote code for constrained TC policy in EViews when there is
'    a single instrument
'
' 3. Fixed code for constrained TC policy in R -- still need to do matlab

' Changes (2/16/12)
'
' 1. Fixed problem with constrained optimization when
'    number of evaluation periods is not the same as
'    the number of instrument periods
'    (subroutine mcz_opt_qp).  This undoes part of the
'    1/17/12 change #3
'
' Changes (2/13/12)
'
' 1. Added "d=" option for TC damping factor (!tcdamp)

' Changes (1/30/12)
'
' 1. Modified subroutine mca_opt_qp to set options in matlab
'    quadprog function call
'
' Changes (1/17/12)
'
' 1. Added new subroutine (mcz_opt_tc) and new simtype (opttc)
' 2. Added new keywords:  ideriv, for sopt string
'                /xopen, /xclose for R and matlab
' 3. Modified subroutine mcz_opt_qp so that the dimensions of the
'    initial and transformed constraint matrices are based on !ndrv not !nevl
' 4. Dropped the explicit optqp simtype
'
```

Uses make_frbus_mcevars 164, mce_load_frbus 160, mce_run 88, mcz_opt_qp 138, mcz_opt_tc 143, mcz_sim 105, and mcz_solvit 114.

6.2.2 run model consistent expectations

88 ⟨*run model consistent expectations* 88⟩≡ (211)

```
subroutine mce_run(string m_opts, string a_opts, string s_opts)

' Driver program

%mcestart = @word(@pagesmpl,1)
%mceend = @word(@pagesmpl,2)


' ************************************************
' 1. Examine m_opts string (defines or creates models, mce errors and instruments)
' ************************************************
'
' Case 1: null string (ie, "")
'         => use existing models whose names are contained in %_$_mod_b and
'            %_$_mod_f; use existing objects _$_mce_instrus
'            and _$_mce_errs.
' Case 2: string contains the keywords "create" and "mod=<modname>"
'         => a model named <modname> is in the workfile and contains explicit
'            leads; parse it to create the objects _$_mod_b, _$_mod_f,
'            _$_mce_instrus, and _$_mce_errs
' Case 3: string contains the keywords "mod_b=", "mod_f=", "mce_errs=", "mce_instrus=
'         or the keywords "mod_b=", "mod_f=", "mce_vars="
'         => each keyword must be assigned to a string variable, whose contents are
'            used to define _$_mod_b, _$_mod_f, _$_mce_errs, and
'            _$_mce_instrus


if @isempty(m_opts) = 1 then
' ***************************************
' case 1 code
  !m_case = 1
  !z1 = @isobject(%_$_mod_b)
  !z2 = @isobject(%_$_mod_f)
  !z3 = @isobject("_$_mce_instrus")
  !z4 = @isobject("_$_mce_errs")
  !zsum = !z1+!z2+!z3+!z4
  if !zsum <> 4 then
    %err = "When the first argument to mce_run is a null string, a previous call to
    %err = %err + "mce_run must have placed the names of the backword and "
    %err = 5err + "forward looking models, list of mce instruments names "
    %err = %err + "and list of mce error names in various strings; at least one "
    %err = %err + "these strings either does not exist or contains the name of "
    %err = %err + "an object that does not exist.  Execution terminates."
```

```
  @uiprompt(%err)
  stop
  endif
'find alias of active scenario
%endog_active = {%_$_mod_b}.@endoglist("@active")
%endog_actual = {%_$_mod_b}.@endoglist
%word1_active = @word(%endog_active,1)
%word1_actual = @word(%endog_actual,1)
!a1 = @strlen(%word1_active)- @strlen(%word1_actual)
string _$_sufsim = @right(%word1_active,!a1)

else
m_opts = @lower(m_opts)
m_opts = @replace(m_opts," ","")
m_opts = @replace(m_opts,","," ")
m_opts = " " + m_opts + " "

if @instr(m_opts,"create") and @instr(m_opts,"mod=") then
' ***************************************
' case 2 code
  !m_case = 2
  call mcz_equalopt("mod",m_opts)
  if @len(%temp)>0 then
    %temp1 = @left(%temp,1)
    if %temp1 = "%" then
      %mod  = @lower({%temp})
      else
      %mod  = @lower(%temp)
      endif
    call mcz_parsemod({%mod})
    endif
  else
  !z1 = @instr(m_opts,"mod_b=")
  !z2 = @instr(m_opts,"mod_f=")
  !z3 = @instr(m_opts,"mce_errs=")
  !z4 = @instr(m_opts,"mce_instrus=")
  !z5 = @instr(m_opts,"mce_vars=")
  !zsum1 = (!z1>0)+(!z2>0)+(!z3>0)+(!z4>0)
  !zsum2 = (!z1>0)+(!z2>0)+(!z5>0)
  if !zsum1 = 4 or !zsum2 = 3 then
  ' ***************************************
  ' case 3 code
    !m_case = 3
    call mcz_equalopt("mod_b",m_opts)
    if @len(%temp)>0 then
      %temp = @lower({%temp})
```

```
      %_$_mod_b = %temp
      endif
    call mcz_equalopt("mod_f",m_opts)
    if @len(%temp)>0 then
      %temp = @lower({%temp})
      %_$_mod_f = %temp
      endif
    call mcz_equalopt("mce_errs",m_opts)
    if @len(%temp)>0 then
      %temp = @lower({%temp})
      group _$_mce_errs {%temp}
      endif
    call mcz_equalopt("mce_instrus",m_opts)
    if @len(%temp)>0 then
      %temp = @lower({%temp})
      group _$_mce_instrus {%temp}
      endif

    else
  ' ***************************************
  ' m_opt string does not conform to a valid case
    @uiprompt("first argument to subroutine mce_run is incorrectly specified")
    stop
    endif
  endif
endif

if !m_case = 2 or !m_case = 3 then
  call mcz_hasopt("adds",m_opts)
  if !hasflag = 1 then
    {%_$_mod_b}.addassign @all
    {%_$_mod_f}.addassign @all
    endif
  call mcz_hasopt("track",m_opts)
  if !hasflag = 1 then
    %track = "yes"
    %track_start = @word(@pagesmpl,1)
    %track_end = @word(@pagesmpl,2)
    call mcz_equalopt("tstart",m_opts)
    if @len(%temp)>0 then
      %track_start  = @lower(%temp)
      endif
    call mcz_equalopt("tend",m_opts)
    if @len(%temp)>0 then
      %track_end  = @lower(%temp)
      endif
```

```
      smpl %track_start %track_end
      {%_$_mod_b}.addinit(v=n) @all
      {%_$_mod_f}.addinit(v=n) @all
      endif
    endif

  if !m_case = 2 then
    group _$_mce_errs {{%mod}_targs}
    group _$_mce_instrus {{%mod}_instrus}
    endif

  if !m_case = 3 then
    call mcz_equalopt("mce_vars",m_opts)
    if @len(%temp)>0 then
      %temp = @lower({%temp})
      %errs = @wcross("e",%temp)
      group _$_mce_errs {%errs}
      %instrus = @wcross(%temp,"_a")
      group _$_mce_instrus {%instrus}
      endif
    endif

' ***********************************************
' 2.  Examine a_opts string (specifies mce algorithm)
' ***********************************************
'
' Case 1:  blank string and %existing_algos = "yes"
'          => do not call mcz_algo (use existing settings)
' Case 2:  blank string and %existing_algos <> "yes"
'          => call mcz_algo to set default options
' Case 3:  nonblank string
'          => call mcz_algo using string to set options overrides

  if @isempty(a_opts) = 1 then
    if %existing_algos = "yes" then
      !a_case = 1
      else
      !a_case = 2
      call mcz_algo(%_$_mod_b,%_$_mod_f," ",_$_mce_instrus,_$_mce_errs)
      endif
    else
    !a_case = 3
    call mcz_algo(%_$_mod_b,%_$_mod_f,a_opts,_$_mce_instrus,_$_mce_errs)
    endif
```

```
' ************************************************
' 3. Examine s_opts string (specifies type of simulation)
' ************************************************

  if @isempty(s_opts) = 1 then
    @uiprompt("error:  no simulation action requested")
    stop
    endif

' make a copy of s_opts for parsing within this subroutine
' (the original is passed to other subroutines for additional
' parsing)
  string _$_opts = s_opts
  _$_opts = @lower(_$_opts)
  _$_opts = @replace(_$_opts," ","")
  _$_opts = @replace(_$_opts,","," ")
  _$_opts = " " + _$_opts + " "

' check for keywords that pertain to all simulation types
  call mcz_hasopt("scen",_$_opts)
  if !hasflag = 1 then
    call mcz_equalopt("suf",_$_opts)
    if @len(%temp)>0 then
      string _$_sufsim  = @lower(%temp)
      else
      string _$_sufsim = "_1"
      endif
    %sufsim = _$_sufsim
    %scenname = "mce_sim" + _$_sufsim
    {%_$_mod_b}.scenario(n,a=%sufsim) %scenname
    {%_$_mod_f}.scenario(n,a=%sufsim) %scenname
    endif
  call mcz_equalopt("solveopt",_$_opts)
  {%_$_mod_b}.solveopt(o=n,g=12,z=1e-12)
  {%_$_mod_f}.solveopt(o=n,g=12,z=1e-12)
  if @len(%temp)>0 then
    {%_$_mod_b}.solveopt({{%temp}})
    {%_$_mod_f}.solveopt({{%temp}})
    endif
  call mcz_equalopt("txt",_$_opts)
  if @len(%temp)>0 then
    for !j = 1 to {%temp}.@linecount
      %tmp = @lower({%temp}.@line(!j))
      {%tmp}
      next
    endif
```

```
    !mceshow = 1
    call mcz_equalopt("o",_$_opts)
    if @len(%temp)>0 then
      !mceshow = @val(%temp)
      endif
    call mcz_equalopt("sstart",_$_opts)
    if @len(%temp)>0 then
      %mcestart = @lower(%temp)
      endif
    call mcz_equalopt("send",_$_opts)
    if @len(%temp)>0 then
      %mceend = @lower(%temp)
      endif
    smpl %mcestart %mceend
    !nqtrs = @obssmpl
    call mcz_hasopt("cleanup",_$_opts)
    if !hasflag = 1 then
      %cleanup = "yes"
      else
      %cleanup = "no"
      endif
    call mcz_hasopt("dontstop",_$_opts)
    if !hasflag = 1 then
      %dontstop = "yes"
      if @maxerrs - @errorcount < 2 then
        !tt = @errorcount + 2
        setmaxerrs !tt
        endif
      else
      %dontstop = "no"
      endif

  ' create various program variables and objects that are needed by
  ' all simulation types; compute initial Jacobian in some cases
    call mcz_sim_setup
    if %mcz_sim_setup = "err" then
      %mce_finish = "failed_solve"
      return
      endif

  ' determine simulation type
    call mcz_equalopt("type",_$_opts)
    if @len(%temp) > 0 then
      %simtype = @lower(%temp)
      if %simtype = "single" then
        call mcz_sim(_$_opts)
```

```
    if %mcz_sim = "err" then
      %mce_finish = "failed_solve"
      return
      endif
    else
    if %simtype = "opt" or %simtype = "opttc" then
      call mcz_equalopt("targs",_$_opts)
      if @len(%temp)>0 then
        %targs = @lower(%temp)
        else
        @uiprompt("error:  targs keyword is missing")
        stop
        endif
      call mcz_equalopt("instrus",_$_opts)
      if @len(%temp)>0 then
        %instrus = @lower(%temp)
        else
        @uiprompt("error:  instrus keyword is missing")
        stop
        endif
      call mcz_equalopt("cnstr",_$_opts)
      if @len(%temp)>0 then
        %cnstr = @lower(%temp)
        %cnstrflag = "yes"
        else
        text _$_blanktext
        %cnstr = "_$_blanktext"
        %cnstrflag = "no"
        endif
      call mcz_opt_setup(s_opts,{%instrus},{%targs},{%cnstr})
      else
      @uiprompt("error:  invalid simtype")
      stop
      endif
    endif
  else
  @uiprompt("error:  required simtype keyword not found")
  stop
  endif

endsub
```

Defines:
mce_run, used in chunks 7, 17, 23, 31, 41, 44, 47, 51, 54, 86, 103, and 105.
Uses mcz_algo 98, mcz_equalopt 102a, mcz_hasopt 102b, mcz_opt_setup 127, mcz_parsemod 95, mcz_sim 105, and mcz_sim_setup 103.

6.2.3 determine endogenous and exogenous variables

95 ⟨*determine endogenous and exogenous variables* 95⟩≡ (211)

```
subroutine mcz_parsemod(model modo)
'
' This subroutine takes modo, a model with explicit leads, and creates
' four objects.  The name of each created object starts with the name of the
' input model, which is denoted by <modname>.
'
' 1.  Model _$_<modname>_b is the same as modo but with all leads replaced
'     with exogenous variables
' 2.  Model _$_<modname>_f contains the MCE error equations
' 3.  String <modname>_instrus of the names of the added exogenous variables,
'     which are the instruments to be used to drive the MCE errors to zero
' 4.  String <modname>_targs of the names of the endogenous variables in
'     <modname>_f, which are the names of MCE error variables

' preliminaries
 %ok_chars = "=-+*(^ "
 freeze(_$_modtext) modo.text
 string _$_endog = @lower(modo.@endoglist)
 !nvars = @wcount(_$_endog)
 %leadnames = " "
 %errnames = " "

 %mm = @lower(modo.@name)
 %_$_mod_b = "_$_" + %mm + "_b"
 %_$_mod_f = "_$_" + %mm + "_f"
 model {%_$_mod_b}
 model {%_$_mod_f}


' create model _$_<modname>_b
 smpl @all
 for !i2 = 1 to _$_modtext.@linecount
     %tmp2 = @ltrim(@lower(_$_modtext.@line(!i2)))
     %aa = @left(%tmp2,1)
     if %aa <> "@" then
         for !i1 = 1 to !nvars
             !occurrence = 1
             %tmp1 = @word(_$_endog,!i1) + "("
             !kk = @instr(%tmp2,%tmp1)
             if !kk > 0 then
                 while !kk > 0
                     'three possibilities
                     '  1. it is part of another variable name
```

```
                        '  2. it is a lag
                        '  3. it is a lead
                        '
                        'look at character in %tmp2 just before %tmp1 to make sure that
                        'is not part of a longer variable or coefficient name
                        %before = @mid(%tmp2, !kk-1,1)
                        if @instr(%ok_chars,%before) > 0 then
                            %tmp3 = @mid(%tmp2,!kk)
                            !kkll = @instr(%tmp3,"(")
                            !kkrr = @instr(%tmp3,")")
                            %laglead = @mid(%tmp3,!kkll, !kkrr-!kkll+1)
                            !ll = 0 + {%laglead}
                            if !ll <= 0 then   'it is a lag -- skip it
                               !occurrence = !occurrence + 1
                               endif
                            if !ll > 0 then   'it is a lead -- define a new variable
                                %aaa = @word(_$_endog,!i1) + %laglead
                                %bbb = @word(_$_endog,!i1) + "_ld_" + @str(!ll)
                                series {%bbb} = {%aaa}
                                %tmp4 = @replace(%tmp2,%aaa,%bbb,1)
                                %tmp2 = %tmp4
                                %leadnames = %leadnames + " " + %bbb
                                endif
                            else    'it is part of another variable name -- skip it
                            !occurrence = !occurrence + 1
                            endif
                        !kk = @instr(%tmp2,%tmp1,!occurrence)
                        wend
                    endif
                next
            endif
          {%_$_mod_b}.append {%tmp2}
        next

  ' create _$_<modname>_f
    %leadnames = @wunique(%leadnames)
    'smpl @all
    for !i1 = 1 to @wcount(%leadnames)
        %tmp1 = @word(%leadnames,!i1)
        !k1 = @instr(%tmp1,"_ld_")
        %tmp2 = @left(%tmp1,!k1-1)
        %tmp3 = @mid(%tmp1,!k1+4)
        %tmp4 =  "err_" + %tmp2 + "_" + @str(%tmp3)
        series {%tmp4} = 0
        %errnames = %errnames + " " + %tmp4
        %eqstring = %tmp4 + "=" + %tmp1 + "-" + %tmp2 + "(" + @str(%tmp3) + ")"
```

```
        {%_$_mod_f}.append {%eqstring}
        next

  ' create mce instrument and target strings

    string {%mm}_instrus = %leadnames
    string {%mm}_targs = %errnames


  endsub
```

Defines:
mcz_parsemod, used in chunk 88.

6.2.4 determine default method, linesearch, and other options

98 ⟨*determine default method, linesearch, and other options* 98⟩≡ (211)

```
subroutine mcz_algo(string mcz_mod_b, string mcz_mod_f, string mcz_algo_opts, group

%existing_algos = "yes"

mcz_algo_opts = @lower(mcz_algo_opts)
mcz_algo_opts = @replace(mcz_algo_opts," ","")
mcz_algo_opts = @replace(mcz_algo_opts,","," ")
mcz_algo_opts = " " + mcz_algo_opts + " "

' default values for method options
%meth = "newton"
%jinit = "interp"
!nskip = 12
!jtrigger = .5

' default values for linesearch options
%linemeth = "armijo"
!linetrigger  = .9
!mcelinemax = 10
!lambda = 1.0
!lrat = .5
!mcz_step_max = 1.0

' default values for other options
!mceconv = .00001
!mcemaxiter = 20
!mceptrb = .001
!broymax = 600

' just in case
%terminal = "no"

' are there overrides to defaults?
if @len(mcz_algo_opts) > 0 then

  ' **********************************
  ' look for method option
    call mcz_equalopt("meth",mcz_algo_opts)
    if @len(%temp)>0 then
      %meth  = @lower(%temp)
      if %meth = "broy" then
        %jinit = "bd"
```

```
      %jupdate = "na"
      %linemeth = "lmr"
      !mcemaxiter = 200
      endif
    if %meth = "qnewton" then
      %jinit = "bd"
      %jupdate = "na"
      %linemeth = "lmr"
      !mcemaxiter = 200
      call mcz_equalopt("broymax",mcz_algo_opts)
      if @len(%temp)>0 then
        !broymax = @val(%temp)
        endif
      endif
    if %meth = "ft" then
      %jinit = "identity"
      %jupdate = "na"
      %linemeth = "na"
      !mcemaxiter = 500
      endif
    endif

' *********************************
' look for jinit and jt options
  call mcz_equalopt("jinit",mcz_algo_opts)
  if @len(%temp)>0 then
    %temp = @lower(%temp)
    if @instr(%temp,"interp(") then
      !k1 = @instr(%temp,"(")
      !nskip = -@val(@mid(%temp,!k1))
      %tmp1 = @mid(%temp,!k1)
      %jinit = "interp"
      else
      %jinit = @lower(%temp)
      endif
    endif
  call mcz_equalopt("jt",mcz_algo_opts)
  if @len(%temp)>0 then
    !jtrigger  = @val(%temp)
    endif

' *********************************
' look for jupdate option
  %jupdate = %jinit
  call mcz_equalopt("jupdate",mcz_algo_opts)
  if @len(%temp)>0 then
```

```
    %temp = @lower(%temp)
    if @instr(%temp,"interp(") then
      !k1 = @instr(%temp,"(")
      !nskip = -@val(@mid(%temp,!k1))
      %tmp1 = @mid(%temp,!k1)
      %jupdate = "interp"
      else
      %jupdate = @lower(%temp)
      endif
    endif

' **********************************
' look for options related to linesearch
  call mcz_equalopt("lmeth",mcz_algo_opts)
  if @len(%temp)>0 then
    %linemeth  = @lower(%temp)
    endif
  call mcz_equalopt("lt",mcz_algo_opts)
  if @len(%temp)>0 then
    !linetrigger = @val(%temp)
    endif
  call mcz_equalopt("lmax",mcz_algo_opts)
  if @len(%temp)>0 then
    !mcelinemax = @val(%temp)
    endif
  call mcz_equalopt("lambda",mcz_algo_opts)
  if @len(%temp)>0 then
    !lambda = @val(%temp)
    endif
  call mcz_equalopt("stepmax",mcz_algo_opts)
  if @len(%temp)>0 then
    !mcz_step_max = @val(%temp)
    endif


' **********************************
' look for other options
  call mcz_equalopt("c",mcz_algo_opts)
  if @len(%temp)>0 then
    !mceconv = @val(%temp)
     endif
  call mcz_equalopt("m",mcz_algo_opts)
  if @len(%temp)>0 then
    !mcemaxiter = @val(%temp)
    endif
  call mcz_equalopt("p",mcz_algo_opts)
```

```
    if @len(%temp)>0 then
      !mceptrb = @val(%temp)
      endif

    endif


' *********************************
' verify the MCE instrument and error arguments

  !nmceinstrus = _$_mce_instrus.@count
  !nmcetargs = _$_mce_errs.@count

  if !nmcetargs <> !nmceinstrus then
    @uiprompt("Error:  There must be as many mce errors as there are mce instruments.")
    stop
    endif

' *********************************
' check that mce instruments are exogenous variables or add factors
' in the lag model
  %exog_vnames = {%_$_mod_b}.@exoglist
  %adds_vnames = {%_$_mod_b}.@addfactors
  %exog_vnames = %exog_vnames + " " + %adds_vnames
  %endog_vnames = {%_$_mod_b}.@endoglist
  for !i = 1 to _$_mce_instrus.@count
    %vvv = _$_mce_instrus.@seriesname(!i)
    !cc = @wfindnc(%exog_vnames,%vvv)
    if !cc = 0 then
      %errstring = "mce control variable " + %vvv + " is not an exogenous variable or add facto
      @uiprompt(%errstring)
      stop
      endif
    next

' *********************************
' check that mce errors are endogenous variables in the lead model
  %endog_lnames = {%_$_mod_f}.@endoglist
  for !i = 1 to _$_mce_errs.@count
    %vvv = _$_mce_errs.@seriesname(!i)
    !cc = @wfindnc(%endog_lnames,%vvv)
    if !cc = 0 then
      %errstring = "mce error variable " +  %vvv + " is not an endogenous variable in the lead
      @uiprompt(%errstring)
      stop
      endif
```

```
      next

  endsub
```

Defines:
mcz_algo, used in chunk 88.
Uses mcz_equalopt 102a.

6.2.5 parse options containing equal signs

102a ⟨*parse options containing equal signs* 102a⟩≡ (211)

```
    subroutine mcz_equalopt(string optionstext,string opts)

  ' parse an option that contains an "=" sign
    optionstext = " " + optionstext + "="
    !k10 = @instr(opts,optionstext)
    if !k10 > 0 then
      !k11 = @len(optionstext)
      %tmp10 = @mid(opts,!k10+!k11)
      !k12 = @instr(%tmp10," ")
      %temp = @left(%tmp10,!k12-1)
      else
      %temp = ""
      endif

    endsub
```

Defines:
mcz_equalopt, used in chunks 88, 98, 105, 127, and 160.

6.2.6 parse options not containing equal signs

102b ⟨*parse options not containing equal signs* 102b⟩≡ (211)

```
    subroutine mcz_hasopt(string optionstext,string opts)

  ' parse an option that does not contain an "=" sign
    !k10 = @wfind(opts,optionstext)
    if !k10 > 0 then
      !hasflag = 1
      else
      !hasflag = 0
      endif

    endsub
```

Defines:
mcz_hasopt, used in chunks 88, 105, and 127.

6.2.7 create common variables, strings, matrices, vectors, and tables

103 ⟨*create common variables, strings, matrices, vectors, and tables* 103⟩≡ (211)

```
subroutine mcz_sim_setup

' create various program variables, strings, matrices, vectors, and tables
' that are common to all simulation types

!tmcetargs = !nmcetargs * !nqtrs
!tmceinstrus = !nmceinstrus * !nqtrs
%mce_targ_names = _$_mce_errs.@members
%mce_instru_names = _$_mce_instrus.@members

string _$_mod_f_exog = @lower({%_$_mod_f}.@exoglist)
string _$_mod_b_endog = @lower({%_$_mod_b}.@endoglist)
%fvars = @wintersect(_$_mod_f_exog,_$_mod_b_endog)
{%_$_mod_f}.override {%fvars}

!re_counter = 0


' ***************************************************************************
' create additional matrix/vector objects

vector(!mcemaxiter+1) _$_mce_loss_vec
vector(!mcemaxiter+1) _$_mce_conv_vec
vector( !nmceinstrus*!nqtrs) _$_mce_direction = 0
vector( !nmceinstrus*!nqtrs) _$_mce_instru_vec = 0
vector(!nmcetargs*!nqtrs) _$_mce_gap_vec
matrix _$_mce_ptrb_mat = @filledmatrix(!nqtrs,!nmceinstrus,!mceptrb)
matrix(!nmcetargs*!nqtrs,1) _$_mce_targ_vec
matrix(!tmcetargs,1) _$_mce_targ_dvec


' ***************************************************************************
'  misc

table(!mcemaxiter+2,6) mce_sim_stats


' ***************************************************************************
' compute initial jacobian except when it is an identity matrix
' or when its been created by a previous call to mce_run
if %jinit <> "identity" and !a_case <> 1 then
  !mcetry = 1
```

```
    smpl %mcestart %mceend
    call mcz_solvit
    if %mcz_solvit = "err" then
      %mcz_sim_setup = "err"
      return
      endif

    call mcz_derivs
    endif


  endsub
```

Defines:
  mcz_sim_setup, used in chunk 88.
Uses mce_run 88, mcz_derivs 116, and mcz_solvit 114.

6.2.8 model consistent coefficient simulation

105 ⟨*model consistent coefficient simulation* 105⟩≡ (211)

```
subroutine mcz_sim(string mcz_sim_options)

%mcz_sim = "ok"

' ************************************************
' 1. set options based on defaults and overrides in string mcz_sim_options
' ************************************************

' for some unknown reason, sometimes eviews bombs unless mcz_sim_options
' is assigned to another string before processing it
%mso = mcz_sim_options

%mso = @lower(%mso)
%mso = @replace(%mso," ","")
%mso = @replace(%mso,","," ")
%mso = " " + %mso + " "

%terminal = "no"
%mcevars_b = " "
%mcevars_f = " "

if @len(%mso) > 0 then
  call mcz_hasopt("terminal",%mso)
  if !hasflag = 1 then
    %terminal = "yes"
    call mcz_equalopt("mcevars_b",%mso)
    if @len(%temp)>0 then
      %mcevars_b  = @lower(%temp)
      call mcz_equalopt("mcevars_f",%mso)
      if @len(%temp)>0 then
        %mcevars_f  = @lower(%temp)
        if @wcount(%mcevars_b) <> @wcount(%mcevars_f) then
          %estring = "Error: mcevars_b and mcevars_f have different numbers of variables"
          @uiprompt(%estring)
          stop
          endif
        endif
      endif
    endif
  endif

if %linemeth = "lmr" then
  !mhistory = 4
```

```
    !tmin = .1
    !tmax = .5
    !gammak = 10^(-4)
    endif


' ************************************************
' 2. set up table of iteration-by-iteration statistics
' ************************************************

  if @isobject("mce_sim_stats") then
    delete mce_sim_stats
    endif
  table(!mcemaxiter+2,6) mce_sim_stats
  mce_sim_stats.setwidth(1:1) 6
  mce_sim_stats.setwidth(2:6) 11
  mce_sim_stats.setlines(a2:f2) +b
  setcell(mce_sim_stats,1,1,"iter")
  setcell(mce_sim_stats,1,2,"converge")
  setcell(mce_sim_stats,2,2,"stat")
  setcell(mce_sim_stats,1,3,"SSR")
  setcell(mce_sim_stats,2,3,"stat")
  setcell(mce_sim_stats,1,4,"step")
  setcell(mce_sim_stats,2,4,"length")
  setcell(mce_sim_stats,1,5,"step")
  setcell(mce_sim_stats,2,5,"iters")
  setcell(mce_sim_stats,1,6,"Newton MCE")
  setcell(mce_sim_stats,2,6,"deriv's?")


' ************************************************
' 3. information text file
' ************************************************

  if @isobject("mce_sim_text") then
    delete mce_sim_text
    endif
  text mce_sim_text
  mce_sim_text.append Simulation start = {%mcestart}
  mce_sim_text.append Simulation end   = {%mceend}
  mce_sim_text.append MCE method = %meth
  if %meth = "newton" then
    mce_sim_text.append -- Initial jacobian = %jinit
    if %jinit = "interp" then
      mce_sim_text.append ---- Jacobian interpolation parameter = {!nskip}
      endif
```

```
    mce_sim_text.append  -- Recompute Jacobian based on jtrigger = {!jtrigger}
    mce_sim_text.append  -- Recompute jacobian using method = {%jupdate}
    endif
  if %meth = "broy" or %meth = "qnewton" then
    mce_sim_text.append -- Initial Jacobian approximation = %jinit
    if %jinit = "interp" then
      mce_sim_text.append ---- Interpolation parameter = {!nskip}
      endif
    if %meth = "qnewton" then
      mce_sim_text.append ---- QNewton iteration switch = {!broymax}
      endif
    endif
  if %meth = "ft" then
    mce_sim_text.append -- Fixed step size =   {!lambda}
    endif
  mce_sim_text.append Linesearch method = {%linemeth}
  if %linemeth <> "na" then
    mce_sim_text.append -- Linesearch trigger = {!linetrigger}
    mce_sim_text.append -- Maximum linesearch iterations =   {!mcelinemax}
    endif
  mce_sim_text.append Convergence criteria = {!mceconv}
  mce_sim_text.append Maximum number of MCE iterations = {!mcemaxiter}
  mce_sim_text.append MCE instrument perturbation factor = {!mceptrb}
  mce_sim_text.append Intermediate output level factor = {!mceshow}

  mce_sim_text.append MCE instrument variables  = {%mce_instru_names}
  mce_sim_text.append MCE error variables  = {%mce_targ_names}
  mce_sim_text.append There are {!tmceinstrus} instrument and {!tmcetargs} error observations

  !re_counter = !re_counter + 1

' ***********************************************
' 4. solution iterations
' ***********************************************

  '*********************************
  ' initialize counters, switches, etc.

  !mcetry = 0
  %mce_converge = "no"
  smpl %mcestart %mceend
  _$_mce_instru_vec = @vec(@convert(_$_mce_instrus))

  '*********************************
  ' start of iteration loop
```

```
while !mcetry <= !mcemaxiter and %mce_converge = "no"

  !mcetry = !mcetry + 1
  setcell(mce_sim_stats,!mcetry+2,1,!mcetry-1,0)

  vector _$_instru_prev = _$_mce_instru_vec
  vector _$_gap_prev = _$_mce_gap_vec

  !mcz_step = !mcz_step_max
  call mcz_solvit
  if %mcz_solvit = "err" then
    %mcz_sim = "err"
    return
    endif

  if !mcetry > 1 then
    !gamma =  _$_mce_loss_vec(!mcetry)/_$_mce_loss_vec(!mcetry-1)
    !loss_prev = _$_mce_loss_vec(!mcetry-1)
    setcell(mce_sim_stats,!mcetry+2,5,1,0)
    if %linemeth <> "none" and !gamma > !linetrigger then
      if %linemeth = "lmr" then
        call mcz_lmr
        if %mcz_lmr = "err" then
          %mcz_sim = "err"
          return
          endif
        endif
      if %linemeth = "armijo"  then
        call mcz_armijo
        if %mcz_armijo = "err" then
          %mcz_sim = "err"
          return
          endif
        endif
      endif
    endif

  if !mceshow < 3 then
    statusline mce solution, iteration !mcetry, f(x) = !nconv
    endif

' test for convergence or iteration limit
  mce_sim_stats(!mcetry+2,2) =  _$_mce_conv_vec(!mcetry)
  if _$_mce_conv_vec(!mcetry) < !mceconv then
    %mce_converge = "yes"
    mce_sim_text.append At iteration {!mcetry}, convergence
```

```
    %mce_finish = "yes"
    endif
  if !mcetry = !mcemaxiter and  _$_mce_conv_vec(!mcetry) >= !mceconv then
    mce_sim_text.append No convergence in {!mcemaxiter} iterations
    if %dontstop = "yes" then
      %mce_finish = "no"
      %mce_converge = "yes"
      mce_sim_text.append Terminating call to mce_run, but execution continues
      else
      @uiprompt("No convergence in maximum number of iterations.  Execution terminating.")
      stop
      endif
    endif


' continue if not converged
  if %mce_converge = "no" then

  ' ****************************
  ' Newton algorithm (optionally update MCE jacobian)
    if %meth = "newton" then
      if !mcetry = 1 then
        if %jinit = "identity" then
          matrix _$_mce_der_mat = !dfactor*@identity(!nmceinstrus*!nqtrs)
          endif
        if %jinit = "bd" then
          for !ijj = 1 to !nmcetargs
            !r = (!ijj-1)*!nqtrs
            matrix _$_mce_der_mat_{!ijj} = @subextract(_$_mce_der_mat,!r+1,!r+1,!r+!nqtrs,!r+
            next
          delete(noerr) _$_mce_der_mat
          endif
        if %jinit <> "identity" then
          mce_sim_stats(!mcetry+3,6) = "yes"
          endif
        else
        if (!gamma >= !jtrigger and %jupdate <> "none") then
          %jinit_bac = %jinit
          %jinit = %jupdate
          call mcz_derivs
          %jinit = %jinit_bac
          endif
        endif

      if %jinit = "bd" then
        for !ijj = 1 to !nmcetargs
```

```
        vector _$_vec_adds = -_$_mce_der_mat_{!ijj}*@subextract(_$_mce_gap_vec,(
        matplace(_$_mce_direction,_$_vec_adds,(!ijj-1)*!nqtrs+1,1)
        next
      else
      _$_mce_direction = -(_$_mce_der_mat*_$_mce_gap_vec)
      endif

    endif

' ******************************
' Broyden algorithms
  if %meth = "broy" or %meth = "qnewton" then
    if !mcetry = 1 then
      if %jinit <> "identity" then
        _$_mce_direction = -(_$_mce_der_mat*_$_mce_gap_vec)
        else
        matrix _$_mce_der_mat = @identity(!nmceinstrus*!nqtrs)
        _$_mce_direction = -_$_mce_gap_vec
        endif
      if %jinit = "bd" then
        for !ijj = 1 to !nmcetargs
          !r = (!ijj-1)*!nqtrs
          matrix _$_mce_der_mat_{!ijj} = @subextract(_$_mce_der_mat,!r+1,!r+1,!r-
          next
        if %bmeth = "qnewton" then
          delete(noerr) _$_mce_der_mat
          endif
        endif
      endif
    if !mcetry > 1 then
      vector _$_instru_delta = _$_mce_instru_vec - _$_instru_prev
      vector _$_gap_delta = _$_mce_gap_vec - _$_gap_prev

    ' ***************
      if %meth = "broy" then
        matrix _$_jy = _$_mce_der_mat*_$_gap_delta
        matrix _$_sj = @transpose(_$_instru_delta)*_$_mce_der_mat
        scalar _$_sjf = @sum(@transpose(_$_instru_delta)*_$_jy)
        _$_mce_der_mat = _$_mce_der_mat + ((_$_instru_delta - _$_jy)*_$_sj)/_$_sj
        _$_mce_direction = -(_$_mce_der_mat*_$_mce_gap_vec)
        endif

    ' ***************
      if %meth = "qnewton" then
        if !mcetry = 2 then
        ' create some matrices on first pass
```

```
  vector(!broymax) _$_stp_nrm
  matrix(!tmceinstrus,!broymax) _$_stp
  vector (!broymax) _$_lam_rec
  matrix(!tmceinstrus,1) _$_z
  vector(!broymax) _$_counter
  for !iq = 1 to !broymax
    _$_counter(!iq) = !iq
    next
  endif

if !mcetry <= !broymax + 1 then
  !q = !mcetry-1
  !f = !q
  else
  !q = @mod(!mcetry-1,!broymax) + 1
  !f = !broymax
  call shiftleft(_$_counter,1)
  endif

colplace(_$_stp,_$_instru_delta,!q)
_$_stp_nrm(!q) = @norm(_$_instru_delta,2)
_$_lam_rec(!q) = !mcz_step

if %jinit = "bd" and !mcetry <= !broymax + 1 then
  for !ijj = 1 to !nmcetargs
    vector _$_vec_adds = -_$_mce_der_mat_{!ijj}* @subextract(_$_mce_gap_vec,(!ijj-1
    matplace(_$_z,_$_vec_adds,(!ijj-1)*!nqtrs+1,1)
    next
  else
  _$_z = -_$_mce_gap_vec
  endif

if !mcetry > 2 then
  for !kbroy = 2 to !f
    !k0 = _$_counter(!kbroy)
    !k1 = _$_counter(!kbroy - 1)
    !a = _$_lam_rec(!k1)/_$_lam_rec(!k0)
    !b = _$_lam_rec(!k1) - 1
    _$_z = _$_z + (!a*@columnextract(_$_stp,!k0)+!b*@columnextract(_$_stp,!k1))*(@t
    next
  endif
!nrm2 = _$_stp_nrm(!q)^2
!lam = _$_lam_rec(!q)
!stz = @sum(@transpose(_$_instru_delta)*_$_z)
_$_mce_direction = (!nrm2*_$_z-(1-!lam)*!stz*_$_instru_delta)/(!nrm2-!lam*!stz)
endif
```

```
        endif
      endif

    ' ******************************
    ' Fair-Taylor algorithm
      if %meth = "ft" then
        _$_mce_direction = -!lambda*_$_mce_gap_vec
        endif
    ' ******************************

      endif

    wend

' ************************************************
' 5. final steps
' ************************************************

  scalar _$_iterations = !mcetry

  if !mceshow = 2 then
    close mce_sim_stats
    endif

  if !mceshow = 1 or !mceshow = 2 then
    if @isobject("mce_sim_spool") then
      delete mce_sim_spool
      endif
    spool mce_sim_spool
    mce_sim_spool.append mce_sim_stats
    mce_sim_spool.append mce_sim_text
    mce_sim_spool.name untitled01 mce_sim_stats
    mce_sim_spool.name untitled02 mce_sim_text
    show mce_sim_spool
    endif


  if !mceshow < 3 then
    statusline mcz_sim finished
    endif


  if %simtype = "single" and %cleanup = "yes" then
    delete(noerr) _$_*
    endif
```

```
endsub
```

Defines:
mcz_sim, used in chunks 86, 88, 138, 143, 151, and 153.
Uses mce_run 88, mcz_armijo 124, mcz_derivs 116, mcz_equalopt 102a, mcz_hasopt 102b, mcz_lmr 122, mcz_solvit 114, and shiftleft 158.

6.2.9 solve model consistent instrument values

114 ⟨*solve model consistent instrument values* 114⟩≡ (211)

```
subroutine mcz_solvit

' This subroutine first sets the MCE instrument values based on the current
' optimal direction and choice of step size, and then solves the models

  %mcz_solvit = "ok"

' update instrument values based on current direction and step size
  if !mcetry > 1 then
    mce_sim_stats(!mcetry+2,4) = !mcz_step
    _$_mce_instru_vec = _$_instru_prev + !mcz_step*_$_mce_direction
    matrix _$_tmp_mat = @unvec(_$_mce_instru_vec,!nqtrs)
    mtos(_$_tmp_mat,_$_mce_instrus)
    endif

' solve lag model
  smpl %mcestart %mceend
  !err_before = @errorcount
  {%_$_mod_b}.solve
  !err_after = @errorcount
  if !err_after > !err_before then
    if %dontstop = "yes" then
      %mcz_solvit = "err"
      return
      else
      @uiprompt("Error in solving lag model: execution terminating")
      stop
      endif
    endif

' optionally set terminal conditions on first iteration
  if !mcetry = 1 and %terminal = "yes" then
    call mcz_terminal
    endif

' solve lead model
  smpl %mcestart %mceend
  !err_before = @errorcount
  {%_$_mod_f}.solve
  !err_after = @errorcount
  if !err_after > !err_before then
    if %dontstop = "yes" then
      %mcz_solvit = "err"
```

```
      return
      else
      @uiprompt("Error in solving lead model: execution terminating")
      stop
      endif
    endif

' create group of the solution values of the mce target variables
' on the first iteration
  if !mcetry = 1 then
    {%_$_mod_f}.makegroup _$_mce_errs_sols {%mce_targ_names}
    endif

' compute mce error functions
  _$_mce_targ_vec = @vec(@convert(_$_mce_errs_sols))
  _$_mce_gap_vec = _$_mce_targ_vec
  !nloss = @norm(_$_mce_gap_vec,2)^2
  mce_sim_stats(!mcetry+2,3) = !nloss
  _$_mce_loss_vec(!mcetry) = !nloss
  !nconv =  @max(@abs(_$_mce_gap_vec))
  _$_mce_conv_vec(!mcetry) = !nconv
  if !mcetry > 1 then
    !gamma = !nloss/_$_mce_loss_vec(!mcetry-1)
    endif

  if !mceshow = 2 then
    show mce_sim_stats
    endif

endsub
```

Defines:
mcz_solvit, used in chunks 86, 103, 105, 122, and 124.
Uses mcz_terminal 125.

6.2.10 compute derivatives of mce targets wrt mce instruments

116 ⟨*compute derivatives of mce targets wrt mce instruments* 116⟩≡ (211)

```
subroutine mcz_derivs

'This subroutine computes the derivatives of the mce targets wrt the mce instruments

  mce_sim_stats(!mcetry+2,6) = "yes"
  matrix _$_mce_der_mat = @filledmatrix(!nmceinstrus*!nqtrs,!nmcetargs*!nqtrs,0)

  if !mcetry > 1 then
    '_$_mce_ptrb_mat = @abs(@unvec(!mcz_step*_$_mce_direction,!nqtrs)) + 1e-6
    _$_mce_ptrb_mat = @abs(@unvec(!mcz_step*_$_mce_direction,!nqtrs)) + 1e-4
    endif

  smpl %mcestart %mceend
  _$_mce_targ_vec = @vec(@convert(_$_mce_errs_sols))

  !maxlead = 1

' *********************************
' construct vector that determines when exact derivatives
' need to be computed

' _$_dvec > 0 => period in which derivatives are to be simulated
' _$_dvec = 1 => but derivatives do not have to be spread/interpolated forward or bac
' _$_dvec = 2 => and derivatives have to be spread forward down diagonals
' _$_dvec = 3 => and derivatives have to be spread backward up diagonals
' _$_dvec = 4 => and derivaties have to be interpolated backward along diagonals
' _$_dvec = 5 => hybrid
  vector(!nqtrs) _$_dvec = 0

  ' *********************************
  if %jinit = "every" then
    _$_dvec = _$_dvec + 1
    endif

  ' *********************************
  if %jinit = "interp" then
    _$_dvec(1) = 1
    _$_dvec(!nqtrs-!maxlead) = 4
    for !ij0 = (1+!nskip) to (!nqtrs-!maxlead-1) step !nskip
      _$_dvec(!ij0) = 4
      next
    if !maxlead > 0 then
```

```
      for !ij0 = (!nqtrs-!maxlead+1) to !nqtrs
        _$_dvec(!ij0) = 1
        next
      endif
    if _$_dvec(!nqtrs-!maxlead-1) = 4 then
      _$_dvec(!nqtrs-!maxlead)  = 1
      endif
    endif

' *********************************
  if %jinit = "bd" then
    !bd_col = @floor(!nqtrs/2)
    _$_dvec(!bd_col) = 5
    endif


' *********************************
' code modified 5/27/10 to reduce the number of derivative
' sims by 1 per mc variable -- will work only when
' maxlead = 1
  if %jinit = "linear" then
    _$_dvec(1) = 2
    _$_dvec(!nqtrs) = 3
    '_$_dvec(!nqtrs-!maxlead) = 3
    'for !ij0 = !nqtrs - !maxlead + 1 to !nqtrs
    '  _$_dvec(!ij0) = 1
    '  next
    endif

' *********************************
' *********************************
' Outer loop:  specifies which instrument is shocked
  for !ij1 = 1 to !nmceinstrus
    %instru_name = _$_mce_instrus.@seriesname(!ij1)
    statusline computing MCE derivatives for instrument %instru_name

  ' *********************************
  ' Middle loop:  simulates effects of instrument shock for selected time periods
    !skip = 0
    for !ij2 = 1 to !nqtrs
      !skip = !skip + 1
      if _$_dvec(!ij2) > 0 then
        !perturbit =  _$_mce_ptrb_mat(!ij2,!ij1)
        !col = (!ij1-1)*!nqtrs + !ij2
        smpl %mcestart + !ij2-1 %mcestart + !ij2-1
        {%instru_name} = {%instru_name} + !perturbit
```

```
   smpl %mcestart %mceend
   {%_$_mod_b}.solve
   {%_$_mod_f}.solve
   _$_mce_targ_dvec = @vec(@convert(_$_mce_errs_sols))
   matplace(_$_mce_der_mat,(_$_mce_targ_dvec-_$_mce_targ_vec)/!perturbit,1,!col)
   smpl %mcestart + !ij2-1 %mcestart + !ij2-1
   {%instru_name} = {%instru_name} - !perturbit

 ' *********************************
 ' Inner loop:  place and/or interpolates derivatives
   if %jinit <> "every" then
     for !ij3 = 1 to !nmceinstrus
       !row = (!ij3-1)*!nqtrs + 1
       matrix _$_tempa = @subextract(_$_mce_der_mat,!row,!col,!row+!nqtrs-1,!col

       ' ********************************************************************
       if %jinit = "linear" then

       ' forward loop moves the derivative diagonally down to the right
       ' when _$_dvec = 2
         if _$_dvec(!ij2) = 2 then
         for !ij4 = 1 to (!nqtrs - !maxlead - 1)
           matrix _$_tempb = @subextract(_$_tempa,1,1,!nqtrs-!ij4,1)
           matplace(_$_mce_der_mat,_$_tempb,!row+!ij4,!col+!ij4)
           next
         endif

       ' backward loop moves the derivative diagonally up to the left
       ' when _$_dvec = 3
         if _$_dvec(!ij2) = 3 then
           !ij5 =  !nqtrs - !maxlead - 1
           for !ij4 = 1 to !ij5
             matrix _$_tempb = @subextract(_$_tempa,(1+!ij4),1,!nqtrs-!maxlead,1
             matplace(_$_mce_der_mat,_$_tempb,!row,!col-!ij4)
             next
           endif

       ' fill unassigned elements of last !maxlead rows with zeros when _$_dvec
         if _$_dvec(!ij2) = 3 then
           !ij5 =  !nqtrs - 2
           matrix(1,!ij5) _$_tempc = 0
           for !ij4 = 1 to !maxlead
             matplace(_$_mce_der_mat,_$_tempc,!row+!nqtrs-!ij4,!col-!nqtrs+2)
             next
           endif
```

```
  endif

' ***************************************************************
  if (%jinit = "interp") and (_$_dvec(!ij2) = 4) then
    !nn2 = !nqtrs-!skip+1
    'fill in columns between current and previous derivative
    '_$_tempa holds current derivative, _$_tempb holds previous derivative

    matrix _$_tempa1 = @subextract(_$_tempa,1,1,!skip,1)
    matrix _$_tempa2 = @subextract(_$_tempa,!skip+1,1,!nqtrs,1)

    'previous derivative
    matrix _$_tempb = @subextract(_$_mce_der_mat,!row,!col-!skip,!row+!nqtrs-1,!col-!
    matrix _$_tempb1 = @subextract(_$_tempb,1,1,!nn2-1,1)
    matrix _$_tempb2 = @subextract(_$_tempb,!nn2,1,!nqtrs,1)

    'forward loop moves lower (ie, nonoverlapping) portion of _$_tempb diagonally dow
    for !ij4 = 1 to !skip-1
      matrix _$_tempb2a = @subextract(_$_tempb2,1,1,!skip-!ij4,1)
      matplace(_$_mce_der_mat,_$_tempb2a,!row+!nn2-1+!ij4,!col-!skip+!ij4)
      next

    'backward loop moves upper (ie, nonoverlapping) portion of _$_tempa diagonally up
    for !ij4 = 1 to !skip-1
      matrix _$_tempa1a = @subextract(_$_tempa1,1+!ij4,1,!skip,1)
      matplace(_$_mce_der_mat,_$_tempa1a,!row,!col-!ij4)
      next

    'overlap loop interpolates upper part of _$_tempb and lower part of _$_tempa
    for !ij4 = 1 to !skip-1
      matrix _$_tempc = ((!skip-!ij4)/!skip)*_$_tempb1 + (!ij4/!skip)*_$_tempa2
      matplace(_$_mce_der_mat,_$_tempc,!row+!ij4,!col-!skip+!ij4)
      next

    'optionally interpolate elements of last !maxlead rows across each row
    !qqqq = 0
    if !qqqq = 1 then
      !nn3 = !nqtrs - !maxlead + 1
      matrix _$_tempa3 = @subextract(_$_tempa,!nn3,1,!nqtrs,1)
      matrix _$_tempb3 = @subextract(_$_tempb,!nn3,1,!nqtrs,1)
      for !ij4 = 1 to !skip-1
        matrix _$_tempc = ((!skip-!ij4)/!skip)*_$_tempb3 + (!ij4/!skip)*_$_tempa3
        matplace(_$_mce_der_mat,_$_tempc,!row+!nn3-1,!col-!skip+!ij4)
        next
      endif
```

```
            endif

          '*****************************************************************
          'The bd method takes account of only two own-derivative elements --
          'one on the diagonal and one on the first super diagonal.  The latter is
          'important for one-lead euler equations.
          '
          'there is some crude coding here, reflecting the fact that the full column
          'of the derivatives matrix has already been filled in and needs to be
          'zeroed out

           if (%jinit = "bd") and (_$_dvec(!ij2) = 5) and (!ij1=!ij3) then
             matplace(_$_mce_der_mat,0*_$_mce_targ_dvec,1,!col)
             !diag = _$_tempa(!bd_col,1)
             vector(!nqtrs-1) _$_tempb = _$_tempa(!bd_col-1,1)
             'vector(!nqtrs-1) _$_tempb1 = _$_tempa(!bd_col+1,1)
             matrix(!nqtrs,!nqtrs) _$_tempc
             matrix _$_tempc = !diag*@identity(!nqtrs) + @makediagonal(_$_tempb,1)
             'matrix _$_tempc = !diag*@identity(!nqtrs) + @makediagonal(_$_tempb,1) +
             _$_tempc = @inverse(_$_tempc)
             matplace(_$_mce_der_mat,_$_tempc,!row,!row)
             endif


            '*****************************************************************

             next
            !skip = 0
            endif
          endif
        next
      next
' *********************************

  delete(noerr) _$_tempa _$_tempb _$_tempc _$_tempd

  'recalculate current solution
  smpl %mcestart %mceend
  {%_$_mod_b}.solve
  {%_$_mod_f}.solve


' *********************************
' invert derivative matrix (unless using bd method, in which case
' it's already inverted)
  if %jinit <> "bd" then
```

```
      statusline inverting MCE derivative matrix
      _$_mce_der_mat = @inverse(_$_mce_der_mat)
      endif

  endsub
```

Defines:
mcz_derivs, used in chunks 103 and 105.

6.2.11 model consistent coefficient non-monotone step-length procedure

122 ⟨*model consistent coefficient non-monotone step-length procedure* 122⟩≡ (211)

```
subroutine mcz_lmr

  %mcz_lmr = "ok"

  !step_pos = !mcz_step
  !step_neg = !mcz_step
  %line_converge = "no"
  !nk = _$_mce_loss_vec(1)/(!mcetry)^2
  !loss_prev = _$_mce_loss_vec(!mcetry-1)
  if !mhistory >= (!mcetry-1) then
    vector losshist =  @subextract(_$_mce_loss_vec,1,1,!mcetry-1,1)
    else
    vector losshist = @subextract(_$_mce_loss_vec,!mcetry-!mhistory,1,!mcetry-1,1)
    endif
  !fkbar = @max(losshist)
  for !j = 1 to !mcelinemax
    if !j > 1 then
      !mcz_step = !step_pos
      call mcz_solvit
      if %mcz_solvit = "err" then
        %mcz_lmr = "err"
        return
        endif
      endif
    if !nloss <= (!fkbar + !nk - !gammak*!step_pos^2*!loss_prev) then
      %line_converge = "yes"
      exitloop
      else
      !nloss_pos = !nloss
      !mcz_step = -!step_neg
      call mcz_solvit
      if %mcz_solvit = "err" then
        %mcz_lmr = "err"
        return
        endif
      if !nloss <= (!fkbar + !nk - !gammak*!step_neg^2*!loss_prev) then
        %line_converge = "yes"
        exitloop
        endif
      !nloss_neg = !nloss
      endif
    !alphat = !step_pos^2*!loss_prev/(!nloss_pos + (2*!step_pos-1)*!loss_prev)
```

```
      if !alphat < (!tmin*!step_pos) then
        !step_pos = !tmin*!step_pos
        else
        if !alphat > !tmax*!step_pos then
          !step_pos = !tmax*!step_pos
          else
          !step_pos = !alphat
          endif
        endif
      !alphat = !step_neg^2*!loss_prev/(!nloss_neg + (2*!step_neg-1)*!loss_prev)
      if !alphat < (!tmin*!step_neg) then
        !step_neg = !tmin*!step_neg
        else
        if !alphat > !tmax*!step_neg then
          !step_neg = !tmax*!step_neg
          else
          !step_neg = !alphat
          endif
        endif
      next
    setcell(mce_sim_stats,!mcetry+2,5,!j,0)

  endsub
```

Defines:
  mcz_lmr, used in chunk 105.
Uses mcz_solvit 114.

6.2.12 model consistent armijo optimization rule

124 ⟨*model consistent armijo optimization rule* 124⟩≡ (211)

```
subroutine mcz_armijo

  %mcz_armijo = "ok"

  !iarm = 0
  while ((!nloss > (1-.01*!mcz_step)*!loss_prev) and !iarm < !mcelinemax)
    !mcz_step = !lrat * !mcz_step
    call mcz_solvit
    if %mcz_solvit = "err" then
      %mcz_armijo = "err"
      return
      endif
    !iarm = !iarm + 1
    wend
  setcell(mce_sim_stats,!mcetry+2,5,!iarm,0)

endsub
```

Defines:
`mcz_armijo`, used in chunk 105.
Uses `mcz_solvit` 114.

6.2.13 variable terminal values

125 ⟨*variable terminal values* 125⟩≡ (211)

```
subroutine mcz_terminal

' Set terminal values for all variables in _$_mod_f that might
' appear with leads, based on the simulated values of the corresponding
' variables in _$_mod_b at the end of the simulation period.
' Terminal values of stationary variables equal their last simulated
' level.  Terminal values of nonstationary are based on extrapolating their
' simulated growth rates.
'
' This subroutine is usually called only once per MCE simulation and only
' for MCE simulations of permanent shocks.  Multiple calls to this
' subroutine may result in convergence problems as a result of terminal
' values that drift from iteration to iteration.


' %fvars (variables that are exogenous in _$_mod_f and
' also endogenous in _$_mod_b)

  {%_$_mod_b}.makegroup _$_fvars_sols {%fvars}

  for !ijj = 1 to @wcount(%fvars)
    %tmpa = @lower(@word(%fvars,!ijj))
    %tmpb = _$_fvars_sols.@seriesname(!ijj)
    smpl  %mceend + 8 %mceend + 8
    !tmpmean = @abs(@mean({%tmpa}))
    if !tmpmean > .001 then
      series _$_tmpgrowth = @abs(@movav(d({%tmpa},0,1)/{%tmpa}(-1),8))
      else
      series _$_tmpgrowth = 0
      endif
    !tmpscal = @mean(_$_tmpgrowth)
    if (!tmpscal < .001) then
      'stationary case
      smpl %mceend + 1  @last
      {%tmpb} = {%tmpb}(-1)
      else
      'nonstationary case
      smpl %mceend  %mceend
      series _$_tmpgrowth = @movav(d({%tmpb},0,1)/{%tmpb}(-1),8)
      !tmpscal = @mean(_$_tmpgrowth) + 1
      smpl %mceend + 1  @last
      {%tmpb} = !tmpscal*{%tmpb}(-1)
      endif
```

```
    {%tmpa} = {%tmpb}
    next

' mcevars_f (mce variables in _$_mod_f, if any) have terminal conditions
' based on the values of mcevars_b (proxies for mce variables in _$_mod_b)

  if @wcount(%mcevars_f) > 0 then
    {%_$_mod_b}.makegroup _$_mcevars_b_sols {{%mcevars_b}}
    %mcevars_f1 = {%mcevars_f}
    for !ijj = 1 to  @wcount(%mcevars_f1)
      %tmpa = @lower(@word(%mcevars_f1,!ijj))
      %tmpb = _$_mcevars_b_sols.@seriesname(!ijj)
      smpl %mceend + 8 %mceend + 8
      !tmpmean = @abs(@mean({%tmpa}))
      if !tmpmean > .001 then
        series _$_tmpgrowth = @abs(@movav(d({%tmpa},0,1)/{%tmpa}(-1),8))
        else
        series _$_tmpgrowth = 0
        endif
      !tmpscal = @mean(_$_tmpgrowth)
      if (!tmpscal < .001) then
        'stationary case
        smpl %mceend + 1  @last
        {%tmpb} = {%tmpb}(-1)
        else
        'nonstationary case
        smpl %mceend  %mceend
        series _$_tmpgrowth = @movav(d({%tmpb},0,1)/{%tmpb}(-1),8)
        !tmpscal = @mean(_$_tmpgrowth) + 1
        smpl %mceend + 1  @last
        {%tmpb} = !tmpscal*{%tmpb}(-1)
        endif
      smpl %mceend + 1  %mceend + 8
      {%tmpa} = {%tmpb}
      next
    endif

  mce_sim_text.append Terminal conditions set at iteration {!mcetry}

' once terminal conditions have been set once, turn the switch that
' calls this subroutine off
  %terminal = "no"

endsub
```

Defines:
mcz_terminal, used in chunk 114.

6.2.14 set options based on defaults and overrides

127 ⟨*set options based on defaults and overrides* 127⟩≡ (211)

```
subroutine mcz_opt_setup(string mcz_opt_options, group mcz_opt_instrus, group mcz_opt_targs, te

  statusline mcz_opt_setup


' ************************************************************************
' set up values of options based on defaults and overrides in string mcz_opt_options

  mcz_opt_options = @lower(mcz_opt_options)
  mcz_opt_options = @replace(mcz_opt_options," ","")
  mcz_opt_options = @replace(mcz_opt_options,","," ")
  mcz_opt_options = " " + mcz_opt_options + " "

' default values for options

  if %simtype <> "opttc" then
    !optmaxiter = 15
    !optconv = 1e-05
    else
    !optmaxiter = 50
    !optconv = 1e-06
    !tcdamp = 1
    endif

  !optlinemax = 10
  !optptrb = .01
  !opt_step_max = 1.0
  !optshow = 3
  !mceshow = 3

  %evlstart = %mcestart
  %drvstart = %mcestart
  %freq = @pagefreq
  %evlend = @datestr(@dateadd(@dateval(%evlstart),59,%freq))
  %drvend = @datestr(@dateadd(@dateval(%drvstart),39,%freq))

  %ideriv = "yes"
  %xopen = "yes"
  %xclose = "yes"

' if imposing constraints (mcz_opt_qp)
  %qpswitch = "r"
```

```
  ' are there overrides to defaults?
    if @len(mcz_opt_options) > 0 then
      %opts = "yes"
      else
      %opts = "no"
      endif

    if %opts = "yes" then
      call mcz_equalopt("m",mcz_opt_options)
      if @len(%temp)>0 then
        !optmaxiter  = @val(%temp)
        endif
      call mcz_equalopt("d",mcz_opt_options)
      if @len(%temp)>0 then
        !tcdamp  = @val(%temp)
        endif
      call mcz_equalopt("c",mcz_opt_options)
      if @len(%temp)>0 then
        !optconv  = @val(%temp)
        endif
      call mcz_equalopt("lmax",mcz_opt_options)
      if @len(%temp)>0 then
        !optlinemax  = @val(%temp)
        endif
      call mcz_equalopt("p",mcz_opt_options)
      if @len(%temp)>0 then
        !optptrb  = @val(%temp)
        endif
      call mcz_equalopt("stepmax",mcz_opt_options)
      if @len(%temp)>0 then
        !optstepmax  = @val(%temp)
        endif
      call mcz_equalopt("oo",mcz_opt_options)
      if @len(%temp)>0 then
        !optshow  = @val(%temp)
        !mceshow  = @val(%temp)
        endif
      call mcz_equalopt("lstart",mcz_opt_options)
      if @len(%temp)>0 then
        %evlstart = @lower(%temp)
        endif
      call mcz_equalopt("lend",mcz_opt_options)
      if @len(%temp)>0 then
        %evlend = @lower(%temp)
        endif
      call mcz_equalopt("istart",mcz_opt_options)
```

```
    if @len(%temp)>0 then
      %drvstart = @lower(%temp)
      endif
    call mcz_equalopt("iend",mcz_opt_options)
    if @len(%temp)>0 then
      %drvend = @lower(%temp)
      endif
    call mcz_equalopt("ideriv",mcz_opt_options)
    if @len(%temp)>0 then
      %ideriv = @lower(%temp)
      endif
    call mcz_hasopt("terminal",mcz_opt_options)
    if !hasflag = 1 then
      %terminal = "yes"
      endif
    call mcz_hasopt("matlab",mcz_opt_options)
    if !hasflag = 1 then
      %qpswitch = "matlab"
      endif
    call mcz_hasopt("/xopen",mcz_opt_options)
    if !hasflag = 1 then
      %xopen = "no"
      endif
    call mcz_hasopt("/xclose",mcz_opt_options)
    if !hasflag = 1 then
      %xclose = "no"
      endif

    endif


' ***********************************************************************
' Some preliminaries

' copy group subroutine arguments into objects with fixed names so that they can be
' easily accessed by other subroutines
  copy mcz_opt_instrus     _$_opt_instrus
  copy mcz_opt_targs       _$_opt_targs

  smpl %evlstart %evlend
  !nevl = @obssmpl
  smpl %drvstart %drvend
  !ndrv = @obssmpl


' ************************************
```

```
' Examine the inequality constraints, put them in a table,
' and, if necessary, augment the list of target variables to
' include all constraint variables
if %cnstrflag = "yes" then
  svector _$_opt_cnstr = mcz_opt_cnstr.@svectornb
  !nconstraints = @rows(_$_opt_cnstr)
  if !nconstraints > 0 then
    table(1,1) _$_opt_cnstr_tab
    string _$_opt_cnstr_vars = " "
    call mcz_constraints(_$_opt_cnstr,_$_opt_cnstr_tab,_$_opt_cnstr_vars)
    %extra_targets = @wnotin(@upper(_$_opt_cnstr_vars),_$_opt_targs.@members)
    %extra_targets = @wunique(%extra_targets)
    !nextra = @wcount(%extra_targets)
    if !nextra > 0 then
      for !qq = 1 to !nextra
        %newtarg = @word(%extra_targets,!qq)
        _$_opt_targs.add {%newtarg}
        %newtarg_t = %newtarg + "_t"
        %newtarg_w = %newtarg + "_w"
        smpl @all
        series {%newtarg_t} = 0
        series {%newtarg_w} = 0
        next
      endif
    else
    @uiprompt("Error:  The cnstr keyword is assigned to an empty text file")
    stop
    endif
  endif



' ***************************************************************************
' More preliminaries

  !noptinstrus = _$_opt_instrus.@count
  !nopttargs = _$_opt_targs.@count

  !topttargs = !nopttargs * !nevl
  !toptinstrus = !noptinstrus * !ndrv
  if !topttargs < !toptinstrus then
    statusline Error: more instruments than targets
    stop
    endif

  matrix _$_opt_ptrb_mat = @filledmatrix(!ndrv,!noptinstrus,!optptrb)
```

```
    vector(!optmaxiter+1) _$_opt_loss_vec

    if %ideriv <> "no" then
      matrix _$_opt_der_mat = @filledmatrix(!toptinstrus,!topttargs,0)
      endif

    %opt_targ_names = _$_opt_targs.@members
    %opt_des_names = @wcross(%opt_targ_names,"_t")
    group _$_opt_des {%opt_des_names}
    smpl %evlstart %evlend
    matrix _$_opt_des_vec = @vec(@convert(_$_opt_des))

  ' if number of instruments and targets is the same, the optimal loss is zero,
  ' shortcut formulas can be used, and weights are not necessary
    if !toptinstrus = !topttargs then
      !zero_loss = 1
      matrix _$_opt_wt_mat = @identity(!topttargs)
      else
      !zero_loss = 0
      smpl %evlstart %evlend
      %opt_wt_names = @wcross(%opt_targ_names,"_w")
      group _$_opt_wts {%opt_wt_names}
      matrix _$_opt_wt_mat = @makediagonal(@vec(@convert(_$_opt_wts)))
      endif




  ' ************************************************************************
  ' text file

    text mce_opt_text

    if %cnstrflag = "yes" then
      mce_opt_text.append constrained optimization using {%qpswitch}:  xopen = {%xopen}; xclose =
      else
      mce_opt_text.append unconstrained optimization (EViews)
      endif
    if %simtype = "opt" then
      mce_opt_text.append optimization type = committment
      mce_opt_text.append simulation period:  {%mcestart} - {%mceend}
      mce_opt_text.append loss evalation period: {%evlstart} - {%evlend}
      mce_opt_text.append instrument setting period: {%drvstart} - {%drvend}
      mce_opt_text.append max number of optimization iterations = !optmaxiter
      mce_opt_text.append max number of line search steps per iteration = !optlinemax
      endif
```

```
  if %simtype = "opttc" then
    mce_opt_text.append optimization type = time-consistent nash (discretion)
    mce_opt_text.append first instrument setting period: {%drvstart}
    mce_opt_text.append first simulation period:  {%mcestart} - {%mceend}
    mce_opt_text.append first loss evalation period: {%evlstart} - {%evlend}
    mce_opt_text.append last instrument setting period: {%drvend}
    mce_opt_text.append max number of backward-induction iterations = !optmaxiter
    endif
  mce_opt_text.append convergence criteria = !optconv
  mce_opt_text.append output control parameter = !optshow
  mce_opt_text.append compute instrument derivs? = {%ideriv}
  mce_opt_text.append instrument perturbation factor = !optptrb


' ************************************************************************
' table of iteration-by-iteration statistics

  if @isobject("mce_opt_stats") then
    delete mce_opt_stats
    endif
  table(!optmaxiter+2,7) mce_opt_stats
  mce_opt_stats.setwidth(1:1) 5
  mce_opt_stats.setwidth(1:5) 12
  mce_opt_stats.setlines(a2:g2) +b
  setcell(mce_opt_stats,1,1,"iter")
  setcell(mce_opt_stats,1,2,"f(x)")
  setcell(mce_opt_stats,1,3,"step size")
  setcell(mce_opt_stats,1,4,"convergence")
  setcell(mce_opt_stats,2,4,"statistic")
  setcell(mce_opt_stats,1,5,"linearity")
  setcell(mce_opt_stats,2,5,"statistic")

' ************************************************************************
' call appropriate optimization subroutine

  if %simtype = "opt" and %cnstrflag = "no" then
    call mcz_opt
    endif
  if %simtype = "opt" and %cnstrflag = "yes" then
    call mcz_opt_qp
    endif
  if %simtype = "opttc" then
    call mcz_opt_tc
    endif
```

```
' ************************************************************************
' spool
  if @isobject("mce_opt_spool") then
    delete mce_opt_spool
    endif
  spool mce_opt_spool
  if %simtype = "opt" then
    mce_opt_spool.append mce_opt_stats
    mce_opt_spool.append mce_opt_text
    mce_opt_spool.name untitled01 mce_opt_stats
    mce_opt_spool.name untitled02 mce_opt_text
    endif
  if %simtype = "opttc" then
    mce_opt_spool.append mce_opt_text
    mce_opt_spool.name untitled01 mce_opt_text
    endif

  if !optshow <> 4 then
    show mce_opt_spool
    close mce_opt_stats
    endif

  if %cleanup = "yes" then
    delete(noerr) _$_*
    endif


  endsub
```

Defines:
mcz_opt_setup, used in chunk 88.
Uses mcz_constraints 155, mcz_equalopt 102a, mcz_hasopt 102b, mcz_opt 134, mcz_opt_qp 138, and mcz_opt_tc 143.

6.2.15 main unconstrained optimal control simulation

134 ⟨*main unconstrained optimal control simulation* 134⟩≡ (211)

```
subroutine mcz_opt

'Main subroutine for unconstrained optimal control simulations


' ***************************************************************************
' initialize counters and switches

  !opttry = 0
  %opt_converge = "no"
  !optnonlin = 0
  !optpchloss = 100



' ***************************************************************************
' initial solution

  smpl %mcestart %mceend
  !opt_step = 0
  !opt_step_prev = 0
  call mcz_opt_solve
  if !opttry = 0 and !optloss = 0 then
    %opt_converge = "yes"
    mce_opt_text.append At iteration {!opttry}, convergence
    endif



' ***************************************************************************
' iterate to minimize loss
  smpl %mcestart %mceend
  while !opttry <= !optmaxiter and %opt_converge = "no"

    !opttry = !opttry + 1

  ' ******************************
  ' compute instrument derivatives, hessian, gradient, direction, and
  ' predicted loss assuming the model is linear
    if (%ideriv <> "no" and (!opttry = 1 or @abs(!optnonlin) > .1)) then
      call mcz_opt_deriv
      endif
    if !zero_loss = 0 then
```

```
    matrix _$_opt_hess = 2*_$_opt_der_mat*_$_opt_wt_mat*@transpose(_$_opt_der_mat)
    else
    matrix _$_opt_hess = 2*@transpose(_$_opt_der_mat)
    endif
  if @issingular(_$_opt_hess) = 1 then
    %errstring = "Hessian is singular at iteration " + @str(!opttry)
    @uiprompt(%errstring)
    stop
    endif
  matrix _$_opt_hessinv = @inverse(_$_opt_hess)
  if !zero_loss = 0 then
    matrix _$_opt_grad = 2*_$_opt_der_mat*_$_opt_wt_mat*_$_opt_gap_vec
    else
    matrix _$_opt_grad = 2*_$_opt_gap_vec
    endif
  vector _$_opt_direction = _$_opt_hessinv*_$_opt_grad
  matrix _$_opt_gap_vec_p = _$_opt_gap_vec - @transpose(_$_opt_der_mat) * _$_opt_direction
  !optloss_p = @sum(@transpose(_$_opt_gap_vec_p)*_$_opt_wt_mat*_$_opt_gap_vec_p)

' ******************************
' solve model and compute loss
  !opt_step = !opt_step_max
  !opt_step_prev = 0
  call mcz_opt_solve

' ******************************
' test for nonlinearity
' !optnonlin is the ratio of the actual to predicted percentage reduction in loss less 1.0;
'  the closer the model is to being linear, the closer !optnonlin is to zero
  !ddloss = (_$_opt_loss_vec(!opttry)-_$_opt_loss_vec(!opttry+1))
  if !ddloss <> 0 then
    !optnonlin = (_$_opt_loss_vec(!opttry+1)-!optloss_p) / !ddloss
    else
    !optnonlin = 100
    endif
  mce_opt_stats(!opttry+3,5) = !optnonlin

' ******************************
' Search for a better a step size (Armijo condition and backtracking)
  !opt_loss_dderiv = -@transpose(_$_opt_grad)*_$_opt_direction
  !kk = .01
  !iarm = 0
  while (_$_opt_loss_vec(!opttry+1) > _$_opt_loss_vec(!opttry) + !kk*!opt_step*!opt_loss_dder
    and !iarm < !optlinemax
    !iarm = !iarm + 1
    !opt_step_prev = !opt_step
```

```
    !opt_step = .5*!opt_step
    call mcz_opt_solve
    wend

  ' ******************************
  ' Test for convergence
    if !zero_loss = 1 then
    ' equal number of targets and controls, full rank derivative matrix
    ' => loss has to be less than !optconv
      mce_opt_stats(!opttry+3,4) =  _$_opt_loss_vec(!opttry+1)
      if _$_opt_loss_vec(!opttry+1) < !optconv then
        %opt_converge = "yes"
        endif
      else
    ' !zero_loss = 0 => percentage change in loss from previous iteration has
    ' to be less than !optconv
      !optpchloss =  1-(_$_opt_loss_vec(!opttry+1)/_$_opt_loss_vec(!opttry))
      mce_opt_stats(!opttry+3,4) =  !optpchloss
      if !optpchloss < !optconv then
        %opt_converge = "yes"
        mce_opt_text.append At iteration {!opttry}, convergence
        endif
      endif

    if !opttry = 1 and @abs(!optnonlin) < 1e-7 and !opt_step = 1 then
      %opt_converge = "yes"
      mce_opt_text.append At iteration 1, convergence assumed because model is linear
      endif

    if !opttry = !optmaxiter then
      mce_opt_text.append At iteration {!opttry}, no convergence in {!optmaxiter} ite
      !continue = @uiprompt("Maximum number of optimization iterations reached:  Cont
      if !continue = 2 then
        stop
        else
        %opt_converge = "yes"
        endif
      endif

    if !optshow <> 4 then
      show mce_opt_stats
      endif
    wend
```

```
endsub
```

Defines:
mcz_opt, used in chunk 127.
Uses mcz_opt_deriv 151 and mcz_opt_solve 153.

6.2.16 main optimal control simulation with inequality constraints

138 ⟨*main optimal control simulation with inequality constraints* 138⟩≡ (211)

```
subroutine mcz_opt_qp

' Main subroutine for optimal control simulations with inequality constraints
' (requires either R or matlab)


' The original problem:
'
'   choose x to minimize z = (y-y*)'W(y-y*)
'   under the constraint Cy >= c
'
'   where at each iteration the linearized relationship between
'   the target variables (y) and instrument variables (x) is
'   given by
'
'   y = B'x + k
'
' The transformed problem:  Solve out y
'
'   choose x to minimize z = x'BWB'x + 2(k-y*)'WB'x + const
'   under the constraint CB'x >= c - Ck
'
' The R command -- quadprog::solve.QP(D,d,A,b) -- solves
'
'   min [0.5 * x' D x - d'x] with the constraint A'x >= b
'
' The matlab command -- x = quadprog(D,d,A,b) -- solves
'
'   min [0.5 * x' D x + d'x] with the constraint Ax <= b
'
'             R             matlab
'   D     2BWB'             same
'   d'    2(k-y*)'WB'      -2(k-y*)'WB'
'   A'    CB'              -CB'
'   b     c-Ck             -(c-Ck)
'
'   where k = y - B'x
'


' ***************************************
' Create constraint matrices (C,c)-- dimensions are based on the number
' of periods in which the instruments are set (!ndrv) not the number of
```

```
' periods in which the loss function is evaluated (!nevl)

  if %cnstrflag = "yes" then
    matrix(!nevl * !nconstraints,!nevl*!nopttargs) _$_opt_cnstr_mat = 0
    matrix(!nevl * !nconstraints,1) _$_opt_cnstr_vec = 0
    for !i = 1 to !nconstraints
      !nterms = @val(_$_opt_cnstr_tab(!i,1))
      for !k = 1 to !nterms
        %var = @upper(_$_opt_cnstr_tab(!i,2*!k))
        !coef =  @val(_$_opt_cnstr_tab(!i,2*!k+1))
        !j = @wfindnc(%opt_targ_names,%var)
        for !l = 1 to !nevl
          _$_opt_cnstr_mat((!i-1)*!nevl+!l,(!j-1)*!nevl+!l) = !coef
          next
        next
      for !l = 1 to !nevl
        !coef =  @val(_$_opt_cnstr_tab(!i,2*!nterms+2))
        _$_opt_cnstr_vec((!i-1)*!nevl+!l) = !coef
        next
      next
    else
    !nconstraints = 1
    matrix(!nevl,!nevl*!nopttargs) _$_opt_cnstr_mat = 0
    matrix(!nevl,1) _$_opt_cnstr_vec = 0
    endif


' ************************************************************************
' initialize counters and switches

  !opttry = 0
  %opt_converge = "no"
  !optnonlin = 0
  !optpchloss = 100

  if %qpswitch = "r" and %xopen = "yes" then
    xopen(type=r, case=lower)
    endif
  if %qpswitch = "matlab" and %xopen = "yes" then
    xopen(type=m, case=lower)
    endif


' ************************************************************************
' compute an initial solution, without reference to any constraints
```

```
  smpl %mcestart %mceend
  !opt_step = 0
  !opt_step_prev = 0
  call mcz_opt_solve


' ***************************************************************************
' iterate to minimize loss
  smpl %mcestart %mceend
  while !opttry <= !optmaxiter and %opt_converge = "no"

    !opttry = !opttry + 1

  ' ******************************
  ' compute instrument derivatives
    if %ideriv <> "no" then
      call mcz_opt_deriv
      endif

  ' ******************************
  ' compute qp matrices
    smpl %drvstart %drvend
    vector _$_opt_instru_vec = @vec(@convert(_$_opt_instrus))
    matrix _$_qp_k_vec = _$_opt_targ_vec-@transpose(_$_opt_der_mat)*_$_opt_instru_vec
    matrix qp_d_mat = 2 * _$_opt_der_mat * _$_opt_wt_mat * @transpose(_$_opt_der_mat)
    matrix qp_d_vec = -2 * _$_opt_der_mat*@transpose(_$_opt_wt_mat) _
                      * (_$_qp_k_vec - _$_opt_des_vec)

    matrix qp_a_mat = @transpose(_$_opt_cnstr_mat * @transpose(_$_opt_der_mat))
    matrix qp_b_vec = _$_opt_cnstr_vec - _$_opt_cnstr_mat _
                     * (_$_qp_k_vec - _$_opt_des_vec)

    if !ndrv <> !nevl then
      qp_a_mat = @subextract(qp_a_mat,1,1,!ndrv,!ndrv)
      qp_b_vec = @subextract(qp_b_vec,1,1,!ndrv,1)
      endif

    xput qp_d_mat qp_a_mat qp_d_vec qp_b_vec

  ' ******************************
  ' ******************************
  ' R code

    if %qpswitch = "r" then
      if ((!ndrv = 1) and (!noptinstrus = 1)) then
        xrun "dim(qp_d_mat) <- c(1,1);"
```

```
      xrun "dim(qp_a_mat) <- c(1,1);"
      xrun "dim(qp_d_vec) <- c(1,1);"
      xrun "dim(qp_b_vec) <- c(1,1);"
      endif
    xrun "QP.results <- quadprog::solve.QP(qp_d_mat,qp_d_vec,qp_a_mat,qp_b_vec);"
    xrun "r_xhat <- QP.results$solution;"
    xrun "r_xhat <- as.matrix(r_xhat);"
    xget(type = matrix, name = _$_qp_instru_vec) r_xhat
    endif

' ******************************
' ******************************
' matlab code

  if %qpswitch = "matlab" then
    xrun "qp_d_vec = -qp_d_vec;"
    xrun "qp_a_mat = -qp_a_mat';"
    xrun "qp_b_vec = -qp_b_vec;"
    xrun  "aeq = [];"
    xrun  "beq = [];"
    xrun  "lb = [];"
    xrun  "ub = [];"
    xrun  "xx0 = [];"
    xrun "options = optimset('Algorithm','active-set','LargeScale','off');"
    xrun "matlab_xhat = quadprog(qp_d_mat,qp_d_vec,qp_a_mat,qp_b_vec,aeq,beq,lb,ub,xx0,option
    xget matlab_xhat
    %tmp = matlab_xhat.@type
    if %tmp = "SCALAR" then
      matrix(1,1) _$_qp_instru_vec = matlab_xhat
      else
      matrix _$_qp_instru_vec = matlab_xhat
      delete matlab_xhat
      endif
    endif

' ******************************
' ******************************

' values of target variables in qp (linearized) solution
  matrix _$_qp_targ_vec = @transpose(_$_opt_der_mat)*_$_qp_instru_vec + _$_qp_k_vec

' values of target variables in original model
  smpl %drvstart %drvend
  matrix _$_tt1 = @unvec(@vec(_$_qp_instru_vec),!ndrv)
  mtos(_$_tt1,_$_opt_instrus)
  smpl %mcestart %mceend
```

```
    call mcz_sim(" ")
    smpl %evlstart %evlend
    matrix _$_opt_targ_vec = @vec(@convert(_$_opt_targs_sols))
    matrix _$_opt_gap_vec = _$_opt_targ_vec - _$_opt_des_vec
    !optloss = @sum(@transpose(_$_opt_gap_vec)*_$_opt_wt_mat*_$_opt_gap_vec)
    setcell(mce_opt_stats,!opttry+2,1,!opttry,0)

  ' convergence test is based on the maximum difference between
  ' the target variable values in the linearized and original models
    !conv_stat = @max(abs(_$_qp_targ_vec-_$_opt_targ_vec))
    mce_opt_stats(!opttry+2,2) = !optloss
    mce_opt_stats(!opttry+2,4) = !conv_stat

    if !optshow <> 4 then
      show mce_opt_stats
      endif

    if !conv_stat < !optconv then
      %opt_converge = "yes"
      else
      endif

    wend

  delete(noerr) qp_d_mat qp_a_mat qp_d_vec qp_b_vec


endsub
```

Defines:
mcz_opt_qp, used in chunks 86 and 127.
Uses mcz_opt_deriv 151, mcz_opt_solve 153, and mcz_sim 105.

6.2.17 model consistent optimal time-consistent solution

143 ⟨*model consistent optimal time-consistent solution* 143⟩≡ (211)

```
subroutine mcz_opt_tc


' 1. For a linear model, this code finds the exact time-consistent solution;
'    for a nonlinear model, the calculated solution is based on the
'    linearization of the model as given by the derivatives of the target
'    variables wrt the instrument variables along the baseline.
'
' 2. The basic data matrices include observations for (!nevl+!ndrv-1) periods,
'    which is also the interval over which tracking adds are required.
'
' 3. The simulation, derivative and evaluation periods are assumed to have the
'    same starting date
'
' 4. The solution method is backward induction; if there are no inequality constraints,
'    the method executes in EViews (using matrices); if inequality constraints
'    are present, the method executes in EViews if there is a single
'    instrument and in Matlab or R (depending on the
'    setting of a switch) if there are multiple instruments (which requires
'    a quadratic programming algorithm),


' ************************************
' Create constraint matrices (C,c)-- dimensions are based on the fact that
' each policymaker sets the instruments for a single period

  if %cnstrflag = "yes" then
    matrix(!nconstraints,!nopttargs) _$_opt_cnstr_mat = 0
    matrix(!nconstraints,1) _$_opt_cnstr_vec = 0
    for !i = 1 to !nconstraints
      !nterms = @val(_$_opt_cnstr_tab(!i,1))
      for !k = 1 to !nterms
        %var = @upper(_$_opt_cnstr_tab(!i,2*!k))
        !coef =  @val(_$_opt_cnstr_tab(!i,2*!k+1))
        !j = @wfindnc(%opt_targ_names,%var)
        _$_opt_cnstr_mat(!i,!j) = !coef
        next
      !coef =  @val(_$_opt_cnstr_tab(!i,2*!nterms+2))
      _$_opt_cnstr_vec(!i) = !coef
      next
    endif
```

```
' ********************************************************************************
' initial solution, instrument derivatives, and data matrices


' initial simulation
smpl %mcestart %mceend
if %terminal = "yes" then
  call mcz_sim("terminal")
  %terminal = "no"
  else
  call mcz_sim("  ")
  endif
{%_$_mod_b}.makegroup _$_opt_targs_sols {%opt_targ_names}
!ntot = !ndrv + !nevl - 1

' derivative matrices and submatrices
' _$_opt_der_mat (this is the basic matrix; tc_dmat is its transpose)
' tc_dmat        effect of !ndrv periods of instruments on !ntot periods of targets
' tc_dmat_short  effect of !ndrv periods of instruments on !nevl periods of targets
' tc_dmat1       effect of period 1 instrument on !nevl periods of targets
' tc_dmat2       effect of period 1 instrument on period 1 targets
if %ideriv <> "no" then
  !opttry = 1
  matrix _$_opt_der_mat = @filledmatrix(!toptinstrus,!nopttargs*!ntot,0)
  %evlend_b = %evlend
  %freq = @pagefreq
  !ntot1 = !ntot-1
  %evlend = @datestr(@dateadd(@dateval(%simstart),!ntot1,%freq))
  'call dateshift(%simstart,%evlend,!ntot-1)
  call mcz_opt_deriv
  %evlend = %evlend_b
  matrix tc_dmat = @transpose(_$_opt_der_mat)
  matrix tc_dmat_short = @filledmatrix(!nevl*!nopttargs,!ndrv*!noptinstrus,0)
  for !i = 1 to !toptinstrus
    for !j = 1 to !nopttargs
      !r1 = !ntot*(!j-1)+1
      !r2 = !r1 + !nevl - 1
      matplace(tc_dmat_short,@subextract(tc_dmat,!r1,!i,!r2,!i),!nevl*(!j-1)+1,!i)
      next
    next
  matrix tc_dmat1 = @filledmatrix(!nevl*!nopttargs,!noptinstrus,0)
  for !i = 1 to !noptinstrus
    matplace(tc_dmat1,@columnextract(tc_dmat_short,(!i-1)*!ndrv+1),1,!noptinstrus)
    next
  matrix tc_dmat2 = @filledmatrix(!noptinstrus,!nopttargs,0)
  for !i = 1 to !noptinstrus
```

```
      for !j = 1 to !nopttargs
        tc_dmat2(!i,!j) = tc_dmat1((!j-1)*!nevl+1,!i)
        next
      next
    endif

' initial simulation again (is this necessary)
  call mcz_sim(" ")

' data matrices
  smpl %simstart {%evlend} + !ndrv - 1
  stom(_$_opt_targs_sols,tc_ymat)
  stom(_$_opt_des,tc_ystarmat)
  stom(_$_opt_instrus,tc_xmat)
  matrix tc_wmat = _$_opt_wt_mat

' (no constraints) => eviews;
' (1 constraint -- single period) => eviews
' (multiple constraints) => R or Matlab
  if %cnstrflag = "no" then
    %iii = "eviews"
    else
    if !noptinstrus = 1 then
      %iii = "eviews"
      else
      %iii = %qpswitch
      endif
    endif

  scalar tc_iter = 0
  scalar tc_stat = 100
  scalar tc_itmax = !optmaxiter
  scalar tc_conv = !optconv


' ***************************************************************************
' unconstrained backward induction => EViews

  if %cnstrflag = "no" then
    while (tc_stat > tc_conv) and tc_iter <= tc_itmax

      matrix tc_xb = tc_xmat
      matrix tc_yb = tc_ymat

      for !i = !ndrv to 1 step -1
        !n1 = !i+!nevl-1
```

```
      !n2 = !i+!ndrv-1
      vector tc_y0v = @vec(@subextract(tc_ymat,!i,1,!n1,!nopttargs))
      vector tc_ys0v = @vec(@subextract(tc_ystarmat,!i,1,!n1,!nopttargs))
      vector tc_x0v =  @vec(@subextract(tc_xmat,!i,1,!n2,!noptinstrus))
      vector tc_x0_1v = @vec(@subextract(tc_xmat,!i,1,!i,!noptinstrus))
      vector tc_xbv =  @vec(@subextract(tc_xb,!i,1,!n2,!noptinstrus))

      vector tc_y1v = tc_y0v + tc_dmat_short*(tc_x0v-tc_xbv)

      matrix tc_g = @transpose(tc_dmat1)*tc_wmat*(tc_y1v-tc_ys0v)
      matrix tc_h = @transpose(tc_dmat1)*tc_wmat*tc_dmat1
      vector tc_x1_1v = tc_x0_1v - !tcdamp*@inverse(tc_h)*tc_g
      matrix tc_x1_1 = @unvec(tc_x1_1v,!noptinstrus)
      matplace(tc_xmat,tc_x1_1,!i,1)
      next

    vector tc_x0v = @vec(@subextract(tc_xmat,1,1,!ndrv,!noptinstrus))
    vector tc_y0v = @vec(@subextract(tc_ymat,1,1,!ntot,!nopttargs))
    vector tc_y1v = tc_y0v + tc_dmat*(tc_x0v-tc_xbv)
    matrix tc_y1 = @unvec(tc_y1v,!ntot)
    matplace(tc_ymat,tc_y1,1,1)

    tc_iter = tc_iter + 1
    if tc_iter > 1 then
      tc_stat = @max(@abs(tc_xmat-tc_xmatprev))
      endif

    matrix tc_xmatprev = tc_xmat
    wend
  endif


' ***************************************************************************
' constrained backward induction

  if %cnstrflag = "yes" then

    matrix tc_cmat = _$_opt_cnstr_mat
    matrix tc_cvec =  _$_opt_cnstr_vec


  ' ***************************************************************************
  ' single-period constraint => eviews
    if %iii = "eviews" then

      statusline constrained TC optimization in EViews
```

```
matrix mat_a = tc_dmat2*@transpose(tc_cmat)

while (tc_stat > tc_conv) and tc_iter <= tc_itmax

  matrix tc_xb = tc_xmat
  matrix tc_yb = tc_ymat

  for !i = !ndrv to 1 step -1
    !n1 = !i+!nevl-1
    !n2 = !i+!ndrv-1

  ' vectors of observations in the current loss and instrument periods
    vector tc_y0v = @vec(@subextract(tc_ymat,!i,1,!n1,!nopttargs))
    vector tc_ys0v = @vec(@subextract(tc_ystarmat,!i,1,!n1,!nopttargs))
    vector tc_x0v =  @vec(@subextract(tc_xmat,!i,1,!n2,!noptinstrus))
    vector tc_x0_1v = @vec(@subextract(tc_xmat,!i,1,!i,!noptinstrus))
    vector tc_xbv =  @vec(@subextract(tc_xb,!i,1,!n2,!noptinstrus))

  ' vector of target variable values based on current instrument values
  ' (ie, solve model)
    vector tc_y1v = tc_y0v + tc_dmat_short*(tc_x0v-tc_xbv)

  ' unconstrained current optimal instrument value
    matrix tc_g = @transpose(tc_dmat1)*tc_wmat*(tc_y1v-tc_ys0v)
    matrix tc_h = @transpose(tc_dmat1)*tc_wmat*tc_dmat1
    vector tc_x1_1v = tc_x0_1v - @inverse(tc_h)*tc_g

  ' check constraint
    matrix tc_y1m = @unvec(tc_y1v,!nevl)
    matrix tc_ysm = @unvec(tc_ys0v,!nevl)
    matrix mattemp = @rowextract(tc_y1m,1) - (@transpose(tc_x0_1v)*tc_dmat2) - @rowextrac
    matrix mat_b = tc_cvec - tc_cmat*@transpose(mattemp)
    scalar testit = @sum(mat_b)/@sum(mat_a)
    if @sum(tc_x1_1v) < testit then
      tc_x1_1v = testit
      !tc_iter = tc_iter
      endif
    vector tc_x1_1v = (1-!tcdamp)*tc_x0_1v + !tcdamp* tc_x1_1v

  ' place current optimal instrument value in instrument matrix
    matrix tc_x1_1 = @unvec(tc_x1_1v,!noptinstrus)
    matplace(tc_xmat,tc_x1_1,!i,1)

    next
```

```
    ' solve model
      vector tc_x0v = @vec(@subextract(tc_xmat,1,1,!ndrv,!noptinstrus))
      vector tc_y0v = @vec(@subextract(tc_ymat,1,1,!ntot,!nopttargs))
      vector tc_y1v = tc_y0v + tc_dmat*(tc_x0v-tc_xbv)
      matrix tc_y1 = @unvec(tc_y1v,!ntot)
      matplace(tc_ymat,tc_y1,1,1)

      tc_iter = tc_iter + 1

      if tc_iter > 1 then
        tc_stat = @max(@abs(tc_xmat-tc_xmatprev))
        endif

      matrix tc_xmatprev = tc_xmat
      wend
    endif


' ***************************************************************************
' multiple constraints => R or matlab

  if %iii = "r" or %iii = "matlab" then

    scalar tc_noptinstrus = !noptinstrus
    scalar tc_nopttargs = !nopttargs
    scalar tc_nevl = !nevl
    scalar tc_ndrv = !ndrv
    scalar tc_damp = !tcdamp

    if %xopen = "yes" then
      if %iii = "r" then
        xopen(type=r)
        xrun library("quadprog")
        %wd = """ + %rpath + """
        xrun setwd({%wd})
        else
        xopen(type=m)
        xrun addpath {%mpath}
        endif
      endif

    xput tc_ymat tc_ystarmat tc_xmat tc_wmat tc_cmat tc_cvec
    xput  tc_nopttargs tc_noptinstrus tc_nevl tc_ndrv tc_itmax tc_conv
    xput tc_dmat tc_dmat1 tc_dmat2 tc_dmat_short tc_damp
```

```
      if %iii = "r" then
        xrun source("tcoc_r.R")
        else
        xrun tcoc_m
        endif

      xget tc_xmat
      xget tc_ymat
      xget tc_iter
      !tc_iter = tc_iter

      if %xclose = "yes" then
        xclose
        endif

      delete(noerr) tc_ystarmat tc_dmat tc_wmat tc_cmat tc_cvec
      delete(noerr) tc_nopttargs tc_noptinstrus tc_nevl tc_ndrv tc_conv
      delete(noerr) tc_damp tc_dmat1 tc_dmat2 tc_dmatshort

      endif
    endif

' ************************************************************************
' examine linearized solution

  if tc_iter >= tc_itmax then
    @uiprompt("iteration limit reached:  time-consistent iterations did not converge")
    'stop
    endif

' write instrument and target values back into their corresponding series
  smpl %evlstart {%evlstart} + !nevl + !ndrv - 2
  mtos(tc_xmat,_$_opt_instrus)
  mtos(tc_ymat,_$_opt_targs_sols)

' value of loss function for linearized solution
  smpl %evlstart %evlend
  matrix _$_opt_targ_vec = @vec(@convert(_$_opt_targs_sols))
  matrix _$_opt_gap_vec = _$_opt_targ_vec - _$_opt_des_vec
  !optloss_lin = @sum(@transpose(_$_opt_gap_vec)*_$_opt_wt_mat*_$_opt_gap_vec)
  stom(_$_opt_targs_sols,tc_ymat_lin)

' simulate EViews model
  smpl %mcestart %mceend
  call mcz_sim("  ")
  smpl %evlstart %evlend
```

```
    stom(_$_opt_targs_sols,tc_ymat_ev)
    !maxdiff = @max(@abs(tc_ymat_ev-tc_ymat_lin))
    matrix _$_opt_targ_vec = @vec(@convert(_$_opt_targs_sols))
    matrix _$_opt_gap_vec = _$_opt_targ_vec - _$_opt_des_vec
    !optloss_ev = @sum(@transpose(_$_opt_gap_vec)*_$_opt_wt_mat*_$_opt_gap_vec)

    !tciter = tc_iter
    mce_opt_text.append time-consistent solution
    mce_opt_text.append --- backward-induction iterations = !tciter
    mce_opt_text.append --- TC damping factor = !tcdamp
    mce_opt_text.append --- linearized solution loss = !optloss_lin
    mce_opt_text.append --- EViews solution loss = !optloss_ev
    mce_opt_text.append --- max diff btwn target vars in linear and EViews sols = !maxd

    delete(noerr) tc_ymat tc_xmat tc_iter tc_ymat_lin tc_ymat_ev
    delete(noerr) tc_itmax tc_stat

  endsub
```

Defines:
  mcz_opt_tc, used in chunks 86 and 127.
Uses dateshift 79, mcz_opt_deriv 151, and mcz_sim 105.

6.2.18 compute derivatives of loss function targets wrt instruments

151 ⟨*compute derivatives of loss function targets wrt instruments* 151⟩≡ (211)

```
subroutine mcz_opt_deriv
'
' requires that the following be defined
'
' !optshow, mce_opt_stats, %evlstart, %evlend
' _$_opt_targs_sols, !noptinstrus, _$_opt_instrus, !drv,
' _$_opt_ptrb_mat, _$_opt_der_mat

' This subroutine computes the derivatives of the loss function targets wrt the instruments

  smpl @all

  !optshow_bac = !optshow
  !optshow = 3

  'make a copy of the current values of the mce instruments;
  'they will be restored after each derivative is computed
  smpl %mcestart %mceend
  stom(_$_mce_instrus,_$_instrus_bac)

  'do not reset terminal conditions when computing derivatives
  %set_terminal = "no"

  smpl %evlstart %evlend
  matrix _$_opt_targ_vec = @vec(@convert(_$_opt_targs_sols))

  '*****************************************
  'derivatives loop
  statusline computing instrument derivatives at optimization iteration !opttry
  for !zi = 1 to !noptinstrus
    %instru_name = _$_opt_instrus.@seriesname(!zi)
    for !zj = 1 to !ndrv
      !perturbit =  _$_opt_ptrb_mat(!zj,!zi)
      smpl %mcestart + !zj-1 %mcestart + !zj-1
      {%instru_name} = {%instru_name} + !perturbit
      call mcz_sim(" ")
      smpl %evlstart %evlend
      matrix _$_opt_targ_dvec = @vec(@convert(_$_opt_targs_sols))
      matplace(_$_opt_der_mat,@transpose(_$_opt_targ_dvec-_$_opt_targ_vec)/!perturbit,(!zi-1)*!
      smpl %mcestart + !zj-1 %mcestart + !zj-1
      {%instru_name} = {%instru_name} - !perturbit
      'restore the original values of the add factors on
```

```
        'the z variable equations
        smpl %mcestart %mceend
        mtos(_$_instrus_bac,_$_mce_instrus)
        next
      next

    smpl %mcestart %mceend

    !optshow = !optshow_bac

  endsub
```

Defines:
mcz_opt_deriv, used in chunks 134, 138, and 143.
Uses mcz_sim 105.

6.2.19 solve model consistent expectations model

153 ⟨*solve model consistent expectations model* 153⟩≡ (211)

```
subroutine mcz_opt_solve

' This subroutine first sets the instrument values, based on the current
' optimal direction and choice of step size, and then solves the model

  statusline optimization solution, iteration !opttry
  smpl %mcestart %mceend

  'compute instrument values based on current direction and step size
  if !opttry > 0 then
    mce_opt_stats(!opttry+3,3) = !opt_step
    smpl %drvstart %drvend
    for !i = 1 to !noptinstrus
      vector _$_temp_adj = @subextract(_$_opt_direction,(!i-1)*!ndrv+1,1,!i*!ndrv,1)
      mtos(_$_temp_adj,_$_temp_ser)
      %y1 = _$_opt_instrus.@seriesname(!i)
      {%y1} = {%y1} - (!opt_step-!opt_step_prev)*_$_temp_ser
      next
    endif

  'solve model
  if !opttry = 0 and %terminal = "yes" then
    call mcz_sim("terminal")
    %terminal = "no"
    else
    call mcz_sim("  ")
    endif

  if !opttry = 0 then
    {%_$_mod_b}.makegroup _$_opt_targs_sols {%opt_targ_names}
    endif

  'compute value of loss function
  smpl %evlstart %evlend
  matrix _$_opt_targ_vec = @vec(@convert(_$_opt_targs_sols))
  matrix _$_opt_gap_vec = _$_opt_targ_vec - _$_opt_des_vec
  !optloss = @sum(@transpose(_$_opt_gap_vec)*_$_opt_wt_mat*_$_opt_gap_vec)
  setcell(mce_opt_stats,!opttry+3,1,!opttry,0)
  mce_opt_stats(!opttry+3,2) = !optloss
  _$_opt_loss_vec(!opttry+1) = !optloss

  if !optshow = 2 then
    show mce_opt_stats
```

```
      endif

  endsub
```

Defines:
  mcz_opt_solve, used in chunks 134 and 138.
Uses mcz_sim 105.

6.2.20 convert mcz inequality constraints

155 ⟨*convert mcz inequality constraints* 155⟩≡ (211)

```
subroutine local mcz_constraints(svector sss, table ctable,string cvarnames)


'This subroutine converts the inequality constraint text into a table

' subroutine arguments:
'
' inputs:
'
'   sss                svector of constraint text
'
' outputs:
'
'   _$_opt_cnstr_tab      table of constraint variables and coefficients
'   _$_opt_cnstr_vars     string of names of variables in constraints

' ************************************

  !nconstraints = @rows(sss)
  scalar loc
  scalar sign

  for !i = 1 to !nconstraints
    %rrr = sss(!i)

  ' ****************************************
  ' ****************************************
  ' separate the left and right sides of each constraint

    !kk1 = @instr(%rrr,">=")
    if !kk1 = 0 then
      @uiprompt("each constraint must contain an ""="" term")
      stop
      endif
    %rrrl = @left(%rrr,!kk1-1)
    if @isempty(%rrrl) = 1 then
      @uiprompt("each constraint must contain terms to the left of ""="""")
      stop
      endif
    %rrrr = @mid(%rrr,!kk1+2)
    if @isempty(%rrrr) = 1 then
      @uiprompt("each constraint must contain a value to the right of ""="""")
      stop
```

```
    endif


' ****************************************
' ****************************************
' process the left side of each constraint
'
' 1. split %rrrl into individual terms (based on + and - characters);
'    the main challenge concerns the first term, which may or may not
'    have a leading + or - attached
' 2. then split each term into 2 parts (based on * character)
' 3. then identify which part is coefficient and which is variable

  !zz = 0    'flag to indicate end of left hand side of a constraint
  !nterms = 1
  vector(100) split_locs = 0
  vector(100) split_signs = 0
  %rrrlx = %rrrl

' find boundaries and signs of each term
  while !zz = 0

  ' first term: determine whether its sign is explicit or implicit
    if !nterms = 1 then
      call find_next_delimit(%rrrlx,loc,sign)
      if loc = 0 then                  'implicit leading sign
        split_locs(!nterms) = 0
        split_signs(!nterms) = 1
        else
        %rrrll = @left(%rrrlx,loc-1)
        if @isempty(%rrrll) = 1 then   'explicit leading sign
          split_locs(!nterms) = loc
          split_signs(!nterms) = sign
          %rrrlx = @mid(%rrrlx,loc+1)
          else                         'implicit leading sign
          split_locs(!nterms) = 0
          split_signs(!nterms) = 1
          endif
        endif
      endif

    call find_next_delimit(%rrrlx,loc,sign)
    if loc = 0 then                  'last term
      split_locs(!nterms+1) = @length(%rrrlx)
      !zz = 1
      else
```

```
      split_locs(!nterms+1) = loc
      split_signs(!nterms+1) = sign
      %rrrlx = @mid(%rrrlx,loc+1)
      endif

    !nterms = !nterms + 1
    wend

  for !k = 2 to !nterms
    split_locs(!k) = split_locs(!k-1) + split_locs(!k)
    next

  !nterms = !nterms - 1


' parse each term into coefficient times variable (they must
' appear in that order, although coefficients = 1 can be
' omitted), and store coefficient and variable in ctable
  for !k = 1 to !nterms
    %term = @mid(%rrrl,split_locs(!k)+1,split_locs(!k+1)-split_locs(!k)-1)
    if @isempty(%term) = 1 then
      @uiprompt("term is empty:  illegal constraint specification")
      stop
      else
      !ii = @instr(%term,"*")
      if !ii > 0 then
        %coef = @left(%term,!ii-1)
        !coef = split_signs(!k) * @val(%coef)
        %var =  @mid(%term,!ii+1)
        else
        !coef = split_signs(!k)
        %var = %term
        endif
      %var = @trim(%var)
      endif

    ctable(!i,2*!k) = %var
    ctable(!i,2*!k+1) = !coef
    cvarnames = cvarnames + " " + %var
    next


' ***************************************
' ***************************************
' process the right side of each constraint
```

```
      ctable(!i,2*!nterms+2) = @val(%rrrr)
      ctable(!i,1) = !nterms

    next

    cvarnames = @wunique(cvarnames)

  endsub
```

Defines:
mcz_constraints, used in chunk 127.
Uses find_next_delimit 159.

6.2.21 shift left

158 ⟨*shift left* 158⟩≡ (211)

```
  subroutine local shiftleft(vector abc, scalar nshift)

    !rows = @rows(abc)
    vector v1 = @subextract(abc,1,1,nshift,1)
    vector v2 = @subextract(abc,nshift+1,1,!rows,1)
    matplace(abc,v2,1)
    matplace(abc,v1,!rows - nshift + 1)

  endsub
```

Defines:
shiftleft, used in chunk 105.

6.2.22 find next delimiter

159 ⟨*find next delimiter* 159⟩≡ (211)

```
subroutine local find_next_delimit(string %instring,scalar loc,scalar sign)

  !ttp = @instr(%instring,"+")
  !ttm = @instr(%instring,"-")
  if !ttp= 0 or !ttm = 0 then
    loc = !ttp + !ttm
    if !ttp = 0 and !ttm = 0 then
      sign = 1
      else
      sign = (!ttp > 0) - (!ttm > 0)
      endif
    else
    loc = !ttp*(!ttp < !ttm) + !ttm*(!ttm < !ttp)
    sign = (!ttp < !ttm) - (!ttm < !ttp)
  endif

endsub
```

Defines:
find_next_delimit, used in chunk 155.

6.2.23 load frbus with transformed subsidiary model

160 ⟨*load frbus with transformed subsidiary model* 160⟩≡ (211)

```
subroutine mce_load_frbus(string frbus_opts)

' take two corresponding FRB/US models (eg, stdver and pfver) and make
' the transformations needed to the second model so that the pair of
' models can be used with the mcz_solve_subs programs

' parameters
'   required:  mce_vars, mod_b, mod_f, path_b, path_f
'   optional:  allbut, only
'

  !allbut = 0
  !only = 0

  frbus_opts = @lower(frbus_opts)
  frbus_opts = @replace(frbus_opts," ","")
  frbus_opts = @replace(frbus_opts,","," ")
  frbus_opts = " " + frbus_opts + " "

  if @isempty(frbus_opts) = 0 then
    call mcz_equalopt("mce_vars",frbus_opts)
    if @len(%temp)>0 then
      %mce_vars  = @lower({%temp})
      else
      @uiprompt("Error:  mce_load_frbus sub requires the mce_vars argument")
      stop
      endif
    call mcz_equalopt("mod_b",frbus_opts)
    if @len(%temp)>0 then
      %mod_b  = {%temp}
      else
      @uiprompt("Error:  mce_load_frbus sub requires the mod_b argument")
      stop
      endif
    call mcz_equalopt("mod_f",frbus_opts)
    if @len(%temp)>0 then
      %mod_f  = {%temp}
      else
      @uiprompt("Error:  mce_load_frbus sub requires the mod_f argument")
      stop
      endif
    call mcz_equalopt("path_b",frbus_opts)
    if @len(%temp)>0 then
```

```
    %path_b  = {%temp}
    else
    @uiprompt("Error:  mce_load_frbus sub requires the path_b argument")
    stop
    endif
  call mcz_equalopt("path_f",frbus_opts)
  if @len(%temp)>0 then
    %path_f  = {%temp}
    else
    @uiprompt("Error:  mce_load_frbus sub requires the path_f argument")
    stop
    endif
  call mcz_equalopt("allbut",frbus_opts)
  if @len(%temp)>0 then
    !allbut = 1
    %allbut  = {%temp}
    else
    call mcz_equalopt("only",frbus_opts)
    if @len(%temp)>0 then
      !only = 1
      %only  = {%temp}
      endif
    endif
  endif

' Added so that users may ask directly for a group of forward-looking equations instead of
' passing in a list that may change in the future.

' Model consistent Asset Pricing
  %s_mcap = " zdivgr zgap05 zgap10 zpi10f zpic30 zrff10 zrff5 zgap30 zrff30 zpi10 zpib5 zpic58"

' Wages and prices
  %s_wp = " zpicxfe zpieci "

' Others - all PAC expectations
  %s_other = " zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvps zvpi zxnfbd zxnfbs zxnfbi zyh zyhp zyht

  if %mce_vars = "-all" then
    %mce_vars = %s_mcap + %s_wp + %s_other
    endif
  if %mce_vars = "-mcap" then
    %mce_vars = %s_mcap
    endif
  if %mce_vars = "-wp" then
    %mce_vars = %s_wp
    endif
```

```
  if %mce_vars = "-mcap+wp" then
    %mce_vars = %s_mcap + %s_wp
    endif
  if @left(%mce_vars, 7) = "-allbut" then
    %tmp = %mce_vars
    %s_remove = @replace(%tmp, "-allbut", "")
    %mce_vars = @wnotin(%s_mcap + %s_wp + %s_other, %s_remove)
    endif
  string zvar_list = %mce_vars
  %zvars = %mce_vars


' backward-looking model

  ld_frbus_cfs(modelname=%mod_b,modelpath=%path_b)
  if !allbut = 1 then
    %tmp = "allbut " + %allbut
    ld_some_eqs(modelname=%mod_b,modelpath=%path_b,eqnames=%tmp)
    endif
  if !only = 1 then
    %tmp = %only
    ld_some_eqs(modelname=%mod_b,modelpath=%path_b,eqnames=%tmp)
    endif
  if !allbut = 0 and !only = 0 then
    ld_frbus_eqs(modelname=%mod_b,modelpath=%path_b)
    endif

' model with mce equations and errors

  ld_mce_eqs(pfname=%mod_f,pfpath=%path_f,mcename=%mod_f,mceeqs=%mce_vars)
  ld_mce_cfs(pfname=%mod_f,pfpath=%path_f,mceeqs=%mce_vars)

  !nmcevars = @wcount(%mce_vars)
  %evars = @wcross("e",%mce_vars)
  for !i = 1 to !nmcevars
    %tmp = @word(%mce_vars,!i)
    %tmpw = " w" + @mid(%tmp,2)
    if %tmp <> "zyh" and %tmp <> "zyhp" and %tmp <> "zyht" then
      %tmp1 = @word(%evars,!i) + "=" + @word(%mce_vars,!i) + "-" + %tmpw
      else
      %tmp1 = @word(%evars,!i) + "= log(" + @word(%mce_vars,!i) + "/" + %tmpw + ")"
      endif
    {%mod_f}.append {%tmp1}
    next

endsub
```

Defines:
mce_load_frbus, used in chunks 7, 17, 23, 31, and 86.
Uses ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, ld_mce_cfs 172b 173, ld_mce_eqs 175 176, ld_some_eqs 180 181, and mcz_equalopt 102a.

6.2.24 create wage and expectation variables in forward looking model

164 ⟨*create wage and expectation variables in forward looking model* 164⟩≡ (211)

```
subroutine make_frbus_mcevars(string frbus_mcevars)

' Create data for the w and e variables in the operational forward looking
' model over the workfile sample currently in effect
'
' The input string contains the names of the expectations variables that
' are to have MC solutions

  %mce_vars = frbus_mcevars

' The user may ask directly for a group of forward-looking equations instead of
' passing in a list that may change in the future.

' Model consistent Asset Pricing
  %s_mcap = " zdivgr zgap05 zgap10 zpi10f zpic30 zrff10 zrff5 zgap30 zrff30 zpi10 zpi

' Wages and prices
  %s_wp = " zpicxfe zpieci "

' Others - all PAC expectations
  %s_other = " zecd zeco zeh zgapc2 zlhp zpi5 zvpd zvps zvpi zxnfbd zxnfbs zxnfbi zyh

  if %mce_vars = "-all" then
    %mce_vars = %s_mcap + %s_wp + %s_other
    endif
  if %mce_vars = "-mcap" then
    %mce_vars = %s_mcap
    endif
  if %mce_vars = "-wp" then
    %mce_vars = %s_wp
    endif
  if %mce_vars = "-mcap+wp" then
    %mce_vars = %s_mcap + %s_wp
    endif
  if @left(%mce_vars, 7) = "-allbut" then
    %tmp = %mce_vars
    %s_remove = @replace(%tmp, "-allbut", "")
    %mce_vars = @wnotin(%s_mcap + %s_wp + %s_other, %s_remove)
    endif


' Data for extra variables associated with MC expectations
```

```
    smpl @all
    for !i = 1 to @wcount(%mce_vars)
      %tmp = @word(%mce_vars,!i)
      %wtmp = "w" + @mid(%tmp,2)
      %wtmp_aerr = %wtmp + "_aerr"
      %etmp = "e" + @word(%mce_vars,!i)
      series {%wtmp} = {%tmp}
      series {%wtmp_aerr} = 0
      series {%etmp} = 0
      next

  endsub
```

Defines:
make_frbus_mcevars, used in chunks 7, 17, 23, 31, and 86.

File Contents

Notice that I've had to change underscores in file and directory names when I create them with noweb. I use the "setup.sh" bash script to create the directory structure, and the "check.sh" bash script to compare the renamed Eview files to the originals. I have to ignore white space in the comparison because the original source files are not consistent with using either Microsoft or Linux line ending characters.

6.3 scripts

6.3.1 setup.sh

167 ⟨*setup.sh* 167⟩≡

```
mkdir -p srcEview/{frbus.package,mce.solve.package,state.space.package}
mkdir -p srcEview/frbus.package/{addins,programs,subs}
mkdir -p srcEview/frbus.package/addins/{ld.frbus.cfs,ld.frbus.eqs,ld.mce.cfs,ld.mce.eqs,ld.some
```

This code is written to file `setup.sh`.

6.3.2 check.sh

168 ⟨*check.sh* 168⟩≡

```
cfile=frbus_package/addins/ld_frbus_cfs/ld_frbus_cfs.prg; ofile=srcEview/frbus.packag
cfile=frbus_package/addins/ld_frbus_eqs/ld_frbus_eqs.prg; ofile=srcEview/frbus.packag
cfile=frbus_package/addins/ld_mce_cfs/ld_mce_cfs.prg; ofile=srcEview/frbus.package/ad
cfile=frbus_package/addins/ld_mce_eqs/ld_mce_eqs.prg; ofile=srcEview/frbus.package/ad
cfile=frbus_package/addins/ld_some_eqs/ld_some_eqs.prg; ofile=srcEview/frbus.package/
cfile=frbus_package/addins/ld_varinfo/ld_varinfo.prg; ofile=srcEview/frbus.package/ad
cfile=frbus_package/addins/regadd.prg; ofile=srcEview/frbus.package/addins/regadd.prg
cfile=frbus_package/programs/example1.prg; ofile=srcEview/frbus.package/programs/exam
cfile=frbus_package/programs/example2.prg; ofile=srcEview/frbus.package/programs/exam
cfile=frbus_package/programs/example3.prg; ofile=srcEview/frbus.package/programs/exam
cfile=frbus_package/programs/example4.prg; ofile=srcEview/frbus.package/programs/exam
cfile=frbus_package/programs/ocpolicy.prg; ofile=srcEview/frbus.package/programs/ocpo
cfile=frbus_package/programs/pings.prg; ofile=srcEview/frbus.package/programs/pings.p
cfile=frbus_package/programs/plot_resids.prg; ofile=srcEview/frbus.package/programs/p
cfile=frbus_package/programs/stochsim.prg; ofile=srcEview/frbus.package/programs/stoc
cfile=frbus_package/subs/master_library.prg; ofile=srcEview/frbus.package/subs/master
cfile=frbus_package/subs/mce_solve_library.prg; ofile=srcEview/frbus.package/subs/mce
cfile=mce_solve_package/example1.prg; ofile=srcEview/mce.solve.package/example1.prg;
cfile=mce_solve_package/example2.prg; ofile=srcEview/mce.solve.package/example2.prg;
cfile=mce_solve_package/example3.prg; ofile=srcEview/mce.solve.package/example3.prg;
cfile=mce_solve_package/example4.prg; ofile=srcEview/mce.solve.package/example4.prg;
cfile=mce_solve_package/example5.prg; ofile=srcEview/mce.solve.package/example5.prg;
cfile=mce_solve_package/mce_solve_library.prg; ofile=srcEview/mce.solve.package/mce.s
cfile=state_space_package/data_transformations.prg; ofile=srcEview/state.space.packag
cfile=state_space_package/estimation_code.prg; ofile=srcEview/state.space.package/est
cfile=state_space_package/frbus_supply_estimation.prg; ofile=srcEview/state.space.pac
cfile=state_space_package/frbus_supply_filter.prg; ofile=srcEview/state.space.package
cfile=state_space_package/initial_values.prg; ofile=srcEview/state.space.package/init
```

This code is written to file `check.sh`.

Uses `data_transformations` 63, `estimation_code` 66, `example1` 3 41, `example2` 7 44, `example3` 11 47, `example4` 17 51, `example5` 54, `frbus.supply.filter` 70, `frbus_supply_estimation` 59, `initial_values` 73, `ld_frbus_cfs` 169a 169b, `ld_frbus_eqs` 170b 171, `ld_mce_cfs` 172b 173, `ld_mce_eqs` 175 176, `ld_some_eqs` 180 181, `ld_varinfo` 184 185, `mce_solve_library` 210 215a, `ocpolicy` 23, `pings` 187d, `plot_resids` 193, `regadd` 186b, and `stochsim` 197.

6.4 frbus package

6.4.1 srcEview/frbus.package/addins/ld.frbus.cfs/ld.frbus.cfs.prg

169a ⟨*srcEview/frbus.package/addins/ld.frbus.cfs/ld.frbus.cfs.prg* 169a⟩≡
⟨*load frbus coefficients* 169b⟩

⟨*load frbus coefficients call* 170a⟩

This code is written to file `srcEview/frbus.package/addins/ld.frbus.cfs/ld.frbus.cfs.prg`.
Defines:
`ld_frbus_cfs`, used in chunks 3, 11, 160, 168, 170a, 186b, 194, and 198.

169b ⟨*load frbus coefficients* 169b⟩≡ (169a)

```
subroutine ld_frbus_cfs(string %mname, string %mpath)

'Load coefficients for frbus version %mname from a text file in directory %mpath
'that has been previously created by the script eq_docs2eviews.

  %cpath = %mpath + %mname  + "_coeffs.txt"
  delete(noerr) coefpath
  text coefpath
  coefpath.append(file) %cpath
  svector coefpathv = coefpath.@svectornb

  for !i = 1 to 900
    svector cofname = @wsplit(coefpathv(!i))
    %y1 = cofname(1)
      if @left(%y1,6) = "theend" then
        exitloop
      endif
    %y2 = cofname(2)
    %y3 = cofname(3)
    coef({%y2}) {%y1}
    {%y1}.fill {%y3}
    next

endsub
```

Defines:
`ld_frbus_cfs`, used in chunks 3, 11, 160, 168, 170a, 186b, 194, and 198.

170a ⟨*load frbus coefficients call* 170a⟩≡ (169a)

```
if @len(@option(1)) < 1  or @len(@option(2)) < 1 then
  @uiprompt("Error: ld_frbus_cfs requires model name and model path")
  stop
endif

%temp = @equaloption("modelname")
if @len(%temp)>0 then
        %mname = %temp
endif
%temp = @equaloption("modelpath")
if @len(%temp)>0 then
        %mpath = %temp
endif

call ld_frbus_cfs(%mname, %mpath)
```

Uses ld_frbus_cfs 169a 169b.

6.4.2 srcEview/frbus.package/addins/ld.frbus.eqs/ld.frbus.eqs.prg

170b ⟨*srcEview/frbus.package/addins/ld.frbus.eqs/ld.frbus.eqs.prg* 170b⟩≡

⟨*load frbus equations* 171⟩

⟨*load frbus equations call* 172a⟩

This code is written to file srcEview/frbus.package/addins/ld.frbus.eqs/ld.frbus.eqs.prg.
Defines:

ld_frbus_eqs, used in chunks 3, 11, 160, 168, 172a, 186b, 194, and 198.

171 ⟨*load frbus equations* 171⟩≡ (170b)

```
subroutine ld_frbus_eqs(string %mname, string %mpath)

'Create eviews model %mname and load it with the equations for frbus version
'%mname that are in a text file in directory %mpath that was previously created
'by the script eq_docs2eviews.

  %epath = %mpath + %mname
  if @fileexist(%epath) <> 1 then
   %epath = %mpath + %mname  + "_eqs.txt"
  endif
  delete(noerr) eqtext
  text eqtext
  eqtext.append(file) %epath
  svector eqtextv = eqtext.@svectornb

  model {%mname}

  !eqnum = 0
  %eqcode = " "

  for !i = 1 to 3000
    %y = eqtextv(!i)
    if @isempty(%y) = 0 then
      'string is not blank
      if @left(%y,6) = "theend" then
        %x = @replace(%eqcode," _"," ")
        {%mname}.append {%x}
        exitloop
        endif

      !k = @instr(%y,":")
      if !k > 0 then
        'string contains the start of a new equation
        !eqnum = !eqnum + 1
        if !eqnum > 0 then
          %x = @replace(%eqcode," _"," ")
          {%mname}.append {%x}
          endif
        %eqcode = @mid(%y,!k+1)

        else
        'string contains the continuation of an equation
        %eqcode = %eqcode + %y
        endif
```

```
    endif
  next

endsub
```

Defines:
ld_frbus_eqs, used in chunks 3, 11, 160, 168, 172a, 186b, 194, and 198.

172a ⟨*load frbus equations call* 172a⟩≡ (170b)

```
if @len(@option(1)) < 1  or @len(@option(2)) < 1 then
  @uiprompt("Error: ld_frbus_eqs requires model name and model path")
  stop
endif

%temp = @equaloption("modelname")
if @len(%temp)>0 then
        %mname = %temp
endif
%temp = @equaloption("modelpath")
if @len(%temp)>0 then
        %mpath = %temp
endif

call ld_frbus_eqs(%mname, %mpath)
```

Uses ld_frbus_eqs 170b 171.

6.4.3 srcEview/frbus.package/addins/ld.mce.cfs/ld.mce.cfs.prg

172b ⟨*srcEview/frbus.package/addins/ld.mce.cfs/ld.mce.cfs.prg* 172b⟩≡

⟨*load mce coefficients* 173⟩

⟨*load mce coefficients call* 174⟩

This code is written to file srcEview/frbus.package/addins/ld.mce.cfs/ld.mce.cfs.prg.
Defines:
ld_mce_cfs, used in chunks 160, 168, 174, and 186b.

173 ⟨*load mce coefficients* 173⟩≡ (172b)

```
subroutine ld_mce_cfs(string %pfname, string %pfpath, string %mceeqs)

'This subroutine is used for setting up the particular type of frbus simulations
'with model-consistent expectations in which a separate model is created
'containing only those expectations equations chosen to have model-consistent
'solutions.  For those expectations variables, the initial z character is replaced
'with w.

'Load coefficients for frbus version %pfname from a text file in directory %pfpath
'that has been previously created by the script eq_docs2eviews.  Only those
'coefficient vectors whose names are in the string %mceeqs are stored.



  %cpath = %pfpath + %pfname  + "_coeffs.txt"
  delete(noerr) coefpathpv
  text coefpathpv
  coefpathpv.append(file) %cpath
  svector coefpathv = coefpathpv.@svectornb

  for !i = 1 to 900
    svector cofname = @wsplit(coefpathv(!i))
    %y1 = cofname(1)
      if @left(%y1,6) = "theend" then
        exitloop
      endif
    %y2 = cofname(2)
    %y3 = cofname(3)
    for !j = 1 to @wcount(%mceeqs)
      %z = @lower(@word(%mceeqs,!j))
      %z1 = @mid(%y1,3)
      if %z = %z1 then
        %y1 = @replace(%y1,"z","w")
        coef({%y2}) {%y1}
        {%y1}.fill {%y3}
        exitloop
      endif
    next
  next


endsub
```

Defines:
ld_mce_cfs, used in chunks 160, 168, 174, and 186b.

174 ⟨*load mce coefficients call* 174⟩≡ (172b)

```
if @len(@option(1)) < 1  or @len(@option(2)) < 1 or @len(@option(3)) < 1  then
  @uiprompt("Error: ld_mce_cfs requires four parameters: pf model  name, pf model pat
  stop
endif

%temp = @equaloption("pfname")
if @len(%temp)>0 then
        %pfname = %temp
endif
%temp = @equaloption("pfpath")
if @len(%temp)>0 then
        %pfpath = %temp
endif
%temp = @equaloption("mceeqs")
if @len(%temp)>0 then
        %mceeqs = %temp
endif
'    ' Added so that users may ask directly for a group of forward-looking equations
'    ' passing in a list that may change in the future.
' '   ' Model consistent Asset Pricing
'    %s_mcap = " zdivgr zgap05 zgap10 zpi10f zpic30 zrff10 zrff5 zgap30 zrff30 zpi10
' '   ' Wages and prices
'    %s_wp = " zpicxfe zpieci "
' '   ' Others - all PAC expectations
'    %s_other = " zecd zeco zeh zgapc2 zlhp zpi5 zpi10 zpib5 zvpd zvps zvpi zxnfbd zx
'    if %mceeqs = "-all" then
'      %mceeqs = %s_mcap + %s_wp + %s_other
'    endif
'    if %mceeqs = "-mcap" then
'      %mceeqs = %s_mcap
'    endif
'    if %mceeqs = "-wp" then
'      %mceeqs = %s_wp
'    endif
'    if %mceeqs = "-mcap+wp" then
'      %mceeqs = %s_mcap + %s_wp
'    endif
'    if @left(%mceeqs, 7) = "-allbut" then
'      %tmp = %mceeqs
'      %s_remove = @replace(%tmp, "-allbut", "")
'      %mceeqs = @wnotin(%s_mcap + %s_wp + %s_other, %s_remove)
'    endif
'    string zvar_list = %mceeqs
'    scalar nzvars = @wcount(%mceeqs)
'    group zvars {%mceeqs}
```

```
call ld_mce_cfs(%pfname, %pfpath, %mceeqs)
```

Uses ld_mce_cfs 172b 173.

6.4.4 srcEview/frbus.package/addins/ld.mce.eqs/ld.mce.eqs.prg

175 ⟨*srcEview/frbus.package/addins/ld.mce.eqs/ld.mce.eqs.prg* 175⟩≡

⟨*load mce equations* 176⟩

⟨*load mce equations call* 179⟩

This code is written to file srcEview/frbus.package/addins/ld.mce.eqs/ld.mce.eqs.prg.
Defines:

ld_mce_eqs, used in chunks 160, 168, 179, and 186b.

176 ⟨*load mce equations* 176⟩≡ (175)

```
subroutine ld_mce_eqs(string %pfname, string %pfpath, string %mcename, string %mceeqs

'This subroutine is used for setting up the particular type of frbus simulations
'with model-consistent expectations in which a separate model is created
'containing only those expectations equations chosen to have model-consistent
'solutions.  For those expectations variables, the initial z character is replaced
'with w.

'Create eviews model %mcename and load it with the equations for frbus version
'%pfname that are in a text file in directory %pfpath that was previously created
'by the script eq_docs2eviews.  Only those equations whose names are in the
'string %mceeqs are included.

' revised 2/11/13 to add a check that version %pfname contains an equation for each
' name in %mceeqs


  %epath = %pfpath + %pfname  + "_eqs.txt"
  delete(noerr) eqtextp
  text eqtextp
  eqtextp.append(file) %epath
  svector eqtextpv = eqtextp.@svectornb

  %coded = " "

  model {%mcename}

  !eqnum = 0
  %eqnew = " "
  %eqold = " "
  %eqcode = " "
  %eqcodeold = " "

  for !i = 1 to 3000

    %appendit = "no"
    %exitloop = "no"
    %y = eqtextpv(!i)
    if @isempty(%y) = 0 then
      'string is not blank
      if @left(%y,6) = "theend" then
        'string contains end-of-file flag
        %appendit = "yes"
        %exitloop = "yes"
        %eqold = %eqnew
```

```
      %eqcodeold = %eqcode
      endif

    !k = @instr(%y,":")
    if !k > 0 then
      'string contains the start of a new equation
      %appendit = "yes"
      !eqnum = !eqnum + 1
      if !eqnum > 0 then
        %eqold = %eqnew
        %eqcodeold = %eqcode
        endif
      %eqnew  = @left(%y,!k-1)
      %eqcode = @mid(%y,!k+1)
      else
      'string contains the continuation of an equation
      %eqcode = %eqcode + %y
      endif

    if %appendit = "yes" then
      'add equation to model only if it is one with mce expectations
      for !j = 1 to @wcount(%mceeqs)
        %z = @lower(@word(%mceeqs,!j))
        if %z = %eqold then
          %x = @replace(%eqcodeold," _"," ")
          %x = @replace(%x,"z","w")
          {%mcename}.append {%x}
          %coded = %coded + " " + %z
          exitloop
          endif
        next
      endif

    if %exitloop = "yes" then
      exitloop
      endif

    endif
  next

' check that model %mcename contains an equation for each variable in %mceeqs
  !j = @wcount(%mceeqs)
  !k = @wcount(%coded)
  if !j <> !k then
    %z = @wnotin(@lower(%mceeqs),@lower(%coded))
    %errstring = "Error in ld_mce_eqs addin: Model " + %mcename
```

```
      %errstring = %errstring + " does not contain equation(s) for variable(s):  " + %z
      %errstring = %errstring + ".  Execution stopped."
      @uiprompt(%errstring)
      stop
      endif

  endsub
```

Defines:
ld_mce_eqs, used in chunks 160, 168, 179, and 186b.

179 ⟨*load mce equations call* 179⟩≡ (175)

```
if @len(@option(1)) < 1  or @len(@option(2)) < 1 or @len(@option(3)) < 1 or @len(@option(4)) <
  @uiprompt("Error: ld_mce_eqs requires five parameters: pf model  name, pf model path, mce mod
  stop
endif

%temp = @equaloption("pfname")
if @len(%temp)>0 then
        %pfname = %temp
endif
%temp = @equaloption("pfpath")
if @len(%temp)>0 then
        %pfpath = %temp
endif
%temp = @equaloption("mcename")
if @len(%temp)>0 then
        %mcename = %temp
endif
%temp = @equaloption("mceeqs")
if @len(%temp) >0 then
        %mceeqs = %temp
endif
'    ' Added so that users may ask directly for a group of forward-looking equations instead of
'    ' passing in a list that may change in the future.
' '   ' Model consistent Asset Pricing
'    %s_mcap = " zdivgr zgap05 zgap10 zpi10f zpic30 zrff10 zrff5 zgap30 zrff30 zpi10 zpib5 "
' '   ' Wages and prices
'    %s_wp = " zpicxfe zpieci "
' '   ' Others - all PAC expectations
'    %s_other = " zecd zeco zeh zgapc2 zlhp zpi5 zpi10 zpib5 zvpd zvps zvpi zxbd zxbs zxbi zyh
'    if %mceeqs = "-all" then
'      %mceeqs = %s_mcap + %s_wp + %s_other
'    endif
'    if %mceeqs = "-mcap" then
'      %mceeqs = %s_mcap
'    endif
'    if %mceeqs = "-wp" then
'      %mceeqs = %s_wp
'    endif
'    if %mceeqs = "-mcap+wp" then
'      %mceeqs = %s_mcap + %s_wp
'    endif
'    if @left(%mceeqs, 7) = "-allbut" then
'      %tmp = %mceeqs
'      %s_remove = @replace(%tmp, "-allbut", "")
'      %mceeqs = @wnotin(%s_mcap + %s_wp + %s_other, %s_remove)
```

```
  '    endif
  '    string zvar_list = %mceeqs
  '    scalar nzvars = @wcount(%mceeqs)
  '    group zvars {%mceeqs}

  call ld_mce_eqs(%pfname, %pfpath, %mcename, %mceeqs)
```

Uses ld_mce_eqs 175 176.

6.4.5 srcEview/frbus.package/addins/ld.some.eqs/ld.some.eqs.prg

180 ⟨*srcEview/frbus.package/addins/ld.some.eqs/ld.some.eqs.prg* 180⟩≡

⟨*load some equations* 181⟩

⟨*load some equations call* 183⟩

This code is written to file srcEview/frbus.package/addins/ld.some.eqs/ld.some.eqs.prg.
Defines:

ld_some_eqs, used in chunks 160, 168, 183, and 186b.

181 ⟨*load some equations* 181⟩≡ (180)

```
subroutine ld_some_eqs(string %mname, string %mpath, string %eqnames)

' Create eviews model %mname and load it with selected equations for frbus version
' %mname that are in a text file in directory %mpath that was previously created
' by the script eq_docs2eviews.  Only those equations whose names match or do not match the
' equation names in the string %eqnames are included.  If the first "word" in %eqnames is
' "allbut", then all equations but those listed will be included.

'*********************************
'parse equation string and put equation names in a table

  %allbut = "no"

  string zlist = " "
  zlist = zlist + %eqnames
  zlist = @trim(zlist)
     if @isempty(zlist) = 1 then
      @uiprompt("Error:  input string to subroutine load_selected_eqtions is empty!!")
      stop
      endif

  if  @wfind(@upper(zlist),"ALLBUT") = 1 then
     %allbut = "yes"
     zlist = @wdrop(zlist,"ALLBUT")
     zlist = @wdrop(zlist,"allbut")
  endif


'*********************************
'parse equation file

  %epath = %mpath + %mname  + "_eqs.txt"
  delete(noerr) eqtext
  text eqtext
  eqtext.append(file) %epath
  svector eqtextv = eqtext.@svectornb

  model {%mname}

  !eqnum = 0
  %eqnew = " "
  %eqold = " "
  %eqcode = " "
  %eqcodeold = " "
```

```
for !i = 1 to 3000
  %appendit = "no"
  %exitloop = "no"
  %y = eqtextv(!i)
  if @isempty(%y) = 0 then
    'string is not blank
    if @left(%y,6) = "theend" then
      %appendit = "yes"
      %exitloop = "yes"
      %eqold = %eqnew
      %eqcodeold = %eqcode
      endif

    !k = @instr(%y,":")
    if !k > 0 then
      'string contains the start of a new equation
      %appendit = "yes"
      !eqnum = !eqnum + 1
      if !eqnum > 0 then
        %eqold = %eqnew
        %eqcodeold = %eqcode
        endif
      %eqnew  = @left(%y,!k-1)
      %eqcode = @mid(%y,!k+1)

      else
      'string contains the continuation of an equation
      %eqcode = %eqcode + %y
      endif

    if %appendit = "yes" then
      'check whether equation should be added to model
      !zswitch = 0
      for !j = 1 to @wcount(zlist)
        %z = @lower(@word(zlist,!j))
        if %z = %eqold then
          !zswitch = 1
          endif
        if  %allbut = "no" and !zswitch = 1 then
          %x = @replace(%eqcodeold," _"," ")
          {%mname}.append {%x}
          exitloop
          endif
        if  %allbut = "yes" and !j = @wcount(zlist) and !zswitch = 0 then
          %x = @replace(%eqcodeold," _"," ")
```

```
            {%mname}.append {%x}
            endif
          next
        endif

      if %exitloop = "yes" then
        exitloop
        endif

      endif
    next



  endsub
```

Defines:
ld_some_eqs, used in chunks 160, 168, 183, and 186b.

183 ⟨*load some equations call* 183⟩≡ (180)

```
  if @len(@option(1)) < 1  or @len(@option(2)) < 1 or @len(@option(3)) < 1 then
    @uiprompt("Error: ld_some_eqs requires model name and model pathand  and eqnames")
    stop
  endif

  %temp = @equaloption("modelname")
  if @len(%temp)>0 then
          %mname = %temp
  endif
  %temp = @equaloption("modelpath")
  if @len(%temp)>0 then
          %mpath = %temp
  endif
  %temp = @equaloption("eqnames")
  if @len(%temp)>0 then
          %eqnames = %temp
  endif

  call ld_some_eqs(%mname, %mpath, %eqnames)
```

Uses ld_some_eqs 180 181.

6.4.6 srcEview/frbus.package/addins/ld.varinfo/ld.varinfo.prg

184 ⟨*srcEview/frbus.package/addins/ld.varinfo/ld.varinfo.prg* 184⟩≡
⟨*load variable information* 185⟩

⟨*load variable information call* 186a⟩

This code is written to file `srcEview/frbus.package/addins/ld.varinfo/ld.varinfo.prg`.
Defines:
`ld_varinfo`, used in chunks 168, 186, 194, and 198.

185 ⟨*load variable information* 185⟩≡ (184)

```
subroutine ld_varinfo(string %pathname)

'Load varinfo information from %pathname in strings

  text vinfo_text
  vinfo_text.append(file) %pathname
  svector varinfo = vinfo_text.@svectornb
  string vinfo_vname = " "
  string vinfo_vtype = " "
  string vinfo_vrule = " "
  string vinfo_sector = " "
  string vinfo_stoch = " "
  string vinfo_decomp = " "
  for !i = 1 to 900
    %y1 = varinfo(!i)
    !ss = @instr(%y1," ")
    %vname = @mid(%y1,!ss+1,8)
    %vname = @rtrim(%vname)
    %vtype = @mid(%y1,!ss+107,1)
    %vrule = @mid(%y1,!ss+109,1)
    if %vrule = " " then
      %vrule = "0"
    endif
    %sector = @mid(%y1,!ss+120,1)
    if %sector = " " then
      %sector = "0"
    endif
    %stoch = @mid(%y1,!ss+128,2)
    %decomp = @mid(%y1,!ss+135,2)
    if %vname = "ZZZBLANK" then
      scalar vinfo_size = !i-1
      exitloop
      endif
   vinfo_vname = vinfo_vname + " " + %vname
   vinfo_vtype = vinfo_vtype + " " + %vtype
   vinfo_vrule = vinfo_vrule + " " + %vrule
   vinfo_sector = vinfo_sector + " " + %sector
   vinfo_stoch = vinfo_stoch + " " + %stoch
   vinfo_decomp = vinfo_decomp + " " + %decomp
  next

endsub
```

Defines:
ld_varinfo, used in chunks 168, 186, 194, and 198.

186a ⟨*load variable information call* 186a⟩≡ (184)

```
if @len(@option(1)) < 1  then
  @uiprompt("Error: ld_varinfo requires varinfo path")
  stop
endif

%temp = @equaloption("pathname")
if @len(%temp)>0 then
        %pathname = %temp
endif


call ld_varinfo(%pathname)
```

Uses ld_varinfo 184 185.

6.4.7 srcEview/frbus.package/addins/regadd.prg

186b ⟨*srcEview/frbus.package/addins/regadd.prg* 186b⟩≡

```
addin(proc="ld_frbus_eqs",desc="Load FRB/US equations") ".\ld_frbus_eqs/ld_frbus_eqs
addin(proc="ld_frbus_cfs",desc="Load FRB/US coefficients") ".\ld_frbus_cfs/ld_frbus_c
addin(proc="ld_mce_eqs",desc="Load MCE equations") ".\ld_mce_eqs/ld_mce_eqs.prg"
addin(proc="ld_mce_cfs",desc="Load MCE coefficients") ".\ld_mce_cfs/ld_mce_cfs.prg"
addin(proc="ld_some_eqs",desc="Load some FRB/US equations") ".\ld_some_eqs/ld_some_eq
addin(proc="ld_varinfo",desc="Load variable information file") ".\ld_varinfo/ld_varin
```

This code is written to file srcEview/frbus.package/addins/regadd.prg.
Defines:
regadd, used in chunk 168.
Uses ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, ld_mce_cfs 172b 173, ld_mce_eqs 175 176, ld_some_eqs 180 181, and ld_varinfo 184 185.

6.4.8 srcEview/frbus.package/programs/example1.prg

186c ⟨*srcEview/frbus.package/programs/example1.prg* 186c⟩≡
⟨*frbus example1* 3⟩

This code is written to file srcEview/frbus.package/programs/example1.prg.

6.4.9 srcEview/frbus.package/programs/example2.prg

186d ⟨*srcEview/frbus.package/programs/example2.prg* 186d⟩≡
⟨*frbus example2* 7⟩

This code is written to file srcEview/frbus.package/programs/example2.prg.

6.4.10 srcEview/frbus.package/programs/example3.prg

187a ⟨*srcEview/frbus.package/programs/example3.prg* 187a⟩≡
⟨*frbus example3* 11⟩
This code is written to file `srcEview/frbus.package/programs/example3.prg`.

6.4.11 srcEview/frbus.package/programs/example4.prg

187b ⟨*srcEview/frbus.package/programs/example4.prg* 187b⟩≡
⟨*frbus example4* 17⟩
This code is written to file `srcEview/frbus.package/programs/example4.prg`.

6.4.12 srcEview/frbus.package/programs/ocpolicy.prg

187c ⟨*srcEview/frbus.package/programs/ocpolicy.prg* 187c⟩≡
⟨*frbus ocpolicy* 23⟩
This code is written to file `srcEview/frbus.package/programs/ocpolicy.prg`.

6.4.13 srcEview/frbus.package/programs/pings.prg

187d ⟨*srcEview/frbus.package/programs/pings.prg* 187d⟩≡
⟨*simulate six ping simulations, aka simple IRFs* 31⟩
```
'************************************************************
'************************************************************
'************************************************************
```
⟨*copy it* 188a⟩

```
'************************************************************
'************************************************************
'************************************************************
```
⟨*plot it* 188b⟩

```
'************************************************************
'************************************************************
'************************************************************
```
⟨*graph it* 189⟩

This code is written to file `srcEview/frbus.package/programs/pings.prg`.
Defines:
`pings`, used in chunks 31 and 168.

188a ⟨*copy it* 188a⟩≡ (187d)

```
subroutine copyit

smpl %simstart %simend
series picnia_{%ping} = picnia{%suf} - picnia
series pic4_{%ping} = pic4{%suf} - pic4
series picx4_{%ping} = picx4{%suf} - picx4
series picxfe_{%ping} = picxfe{%suf} - picxfe
series xgap2_{%ping} = xgap2{%suf} -xgap2
series lur_{%ping} = lur{%suf} - lur
series rff_{%ping} = rff{%suf} - rff

endsub
```

Defines:
`copyit`, used in chunk 31.

188b ⟨*plot it* 188b⟩≡ (187d)

```
subroutine plotit(string %grname, string %width, string %height, string %var1, stri


graph {%grname}.line  {%var1} zero
{%grname}.options size({%width},{%height}) -inbox
{%grname}.setelem(1) linewidth(3) linepattern(1) linecolor(black)
{%grname}.addtext(t,just(c),font(9)) %title
{%grname}.addtext(0,-.15,font(8),just("r")) %units
{%grname}.datelabel format(yyyy)
{%grname}.legend -display
{%grname}.axis(b) font(9)
{%grname}.axis(l) font(9)

endsub
```

Defines:
`plotit`, used in chunk 189.

189 ⟨*graph it* 189⟩≡ (187d)

```
subroutine graphit

smpl %simstart %simstart + 39
series zero = 0

delete(noerr) gr_*


' RFF ping

%ping = "rff"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto Funds Rate"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "b"
%var1 =  "picxfe_" + %ping
%tt = "Response of Core Inflation\rto Funds Rate"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "c"
%var1 =  "rff_" + %ping
%tt = "Response of Funds Rate\rto Funds Rate"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)



' EGFO ping


%ping = "eg"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto Federal Purch"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "b"
%var1 =  "picxfe_"  + %ping
%tt = "Response of Core Inflation\rto Federal Purch"
```

```
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "c"
%var1 =  "egfn_shr_" + %ping
%tt = "Response of Federal Purch\rto Federal Purch"
call plotit(%name,"2","1.5",%var1,%tt,"percent of GDP")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)


' REQP ping

%ping = "reqp"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto Equity Premium"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "b"
%var1 =  "picxfe_" + %ping
%tt = "Response of Core Inflation\rto Equity Premium"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "c"
%var1 =  "reqp_" + %ping
%tt = "Response of Equity Premium\rto Equity Premium"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)



' POILR ping

%ping = "oil"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto Oil Price"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "b"
%var1 =  "picxfe_" + %ping
```

```
%tt = "Response of Core Inflation\rto Oil Price"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "c"
%var1 =  "poil_" + %ping
%tt = "Response of Oil Price\rto Oil Price"
call plotit(%name,"2","1.5",%var1,%tt,"dollars per barrel")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)



' HMFPT ping

%ping = "hmfp"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto MFP Growth"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "b"
%var1 =  "picxfe_" + %ping
%tt = "Response of Core Inflation\rto MFP Growth"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

%name = %ping + "c"
%var1 =  "hmfpt_" + %ping
%tt = "Response of MFP Growth\rto MFP Growth"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)



' MFPT ping

%ping = "mfp"

%name = %ping + "a"
%var1 =  "xgap2_" + %ping
%tt = "Response of Output Gap\rto MFP Level"
call plotit(%name,"2","1.5",%var1,%tt,"percentage points")
```

```
  %name = %ping + "b"
  %var1 =  "picxfe_" + %ping
  %tt = "Response of Core Inflation\rto MFP Level"
  call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

  %name = %ping + "c"
  %var1 =  "mfpt_" + %ping
  %tt = "Response of MFP Level\rto MFP Level"
  call plotit(%name,"2","1.5",%var1,%tt,"percent")

  graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
  gr_{%ping}.align(3,.40,.40)


%ping = "prem"

  %name = %ping + "a"
  %var1 =  "xgap2_" + %ping
  %tt = "Response of Output Gap\rto Term Premium"
  call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

  %name = %ping + "b"
  %var1 =  "picxfe_" + %ping
  %tt = "Response of Core Inflation\rto Term Premium"
  call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

  %name = %ping + "c"
  %var1 =  "rg10p_" + %ping
  %tt = "Response of Term Premium (10-year) \rto Term Premium"
  call plotit(%name,"2","1.5",%var1,%tt,"percent")

  graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
  gr_{%ping}.align(3,.40,.40)

%ping = "exch"

  %name = %ping + "a"
  %var1 =  "xgap2_" + %ping
  %tt = "Response of Output Gap\rto Exchange Rate"
  call plotit(%name,"2","1.5",%var1,%tt,"percentage points")

  %name = %ping + "b"
  %var1 =  "picxfe_" + %ping
  %tt = "Response of Core Inflation\rto Exchange Rate"
  call plotit(%name,"2","1.5",%var1,%tt,"percentage points")
```

```
%name = %ping + "c"
%var1 =  "fpxr_" + %ping
%tt = "Response of  Exchange Rate \rto Exchange Rate"
call plotit(%name,"2","1.5",%var1,%tt,"percent")

graph gr_{%ping}.merge  {%ping}a {%ping}b {%ping}c
gr_{%ping}.align(3,.40,.40)
endsub
```

Defines:
graphit, used in chunk 31.
Uses plotit 188b.

6.4.14 srcEview/frbus.package/programs/plot.resids.prg

193 ⟨*srcEview/frbus.package/programs/plot.resids.prg* 193⟩≡
⟨*plot historical residuals of key equations* 194⟩

```
' ***************************************************************
' ***************************************************************
```

⟨*find variable description* 196⟩

This code is written to file srcEview/frbus.package/programs/plot.resids.prg.
Defines:
plot_resids, used in chunk 168.

194 ⟨*plot historical residuals of key equations* 194⟩≡ (193)

```
' Program to plot the historical residuals of key FRB/US equations
'
' Each residual has the same units of measurement as the
' the left hand side of its equation

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
  include ../subs/master_library

' Workfile
  %wfstart = "1975q1"
  %wfend = "2030q4"
  %mainpage = "main"
  wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

' FRB/US model name and location
  %varmod = "stdver"
  %varpath = "../mods/"
  %varinfo = "../mods/stdver_varinfo"

' Input datbase
  %dbin  = "../data/longbase"

' Plot range
  %plotstart = "1980q1"
  %plotend = "2014q2"


' ************************************************************
' Retrieve data, model equations and coefficients
' ************************************************************

' Load equations and coefficients
  ld_frbus_eqs(modelname=%varmod,modelpath=%varpath)
  ld_frbus_cfs(modelname=%varmod,modelpath=%varpath)
  ld_varinfo(pathname=%varinfo)

' Load data
  dbopen %dbin as longbase
  smpl %plotstart-12 %plotend
  fetch(d=longbase) *
```

```
' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
call group2zero("endog_aerr")

' Compute baseline tracking add factors
smpl %plotstart %plotend
{%varmod}.addassign @all
{%varmod}.addinit(v=n) @all

' ************************************************************
' Plots
' ************************************************************

%plotvars = "eco ecd eh epd epi eps ki ex emo lfpr lhp leo lww"
%plotvars = %plotvars + " picxfe pieci pcer pcfr pcengr"
%plotvars = %plotvars + " rg5p rg10p rg30p rbbbp rcar rme rtbe rcgain"
%plotvars = %plotvars + " ynidn yniin yhibn"

smpl %plotstart %plotend
series zero = 0

spool plot_vars

!counter = 0
for !i = 1 to @wcount(%plotvars)
  %vname = @word(%plotvars,!i)
  call find_var_description
  !counter = !counter + 1
  graph gr_{%vname}.line zero {%vname}_a
  %title = %vname + ": " + %desc
  gr_{%vname}.addtext(t) %title
  gr_{%vname}.axis range(minmax)
  gr_{%vname}.options size(4,3)
  gr_{%vname}.legend -display

  plot_vars.append gr_{%vname}
  %index = "000" + @str(!counter)
  if !counter < 100 then
    %index = @right(%index,2)
    else
    %index = @right(%index,3)
    endif
  %name = "untitled" + %index
  plot_vars.name {%name} {%vname}
```

```
  next

plot_vars.display
```

Uses find_var_description 196, group2zero 81a, groupnew 82, ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, and ld_varinfo 184 185.

This was originally written in Fortran! Look at the *ii*, *jj*, *kk* variable names. I had forgotten about that from when I briefly helped the programmer debug the original model some 45 years ago. Who would have expected nostalgia from something so prosaic. I never saw the original source code because I was working with only a hex dump.

196 ⟨*find variable description* 196⟩≡ (193)

```
subroutine find_var_description

for !j = 1 to 500
  %vline = vinfo_text.@line(!j)
  !eq = @instr(%vline,"=")
  !zz = !eq-4
  %name = @lower(@rtrim(@ltrim(@mid(%vline,4,!zz))))

  if %vname = %name then
    %desc = " "
    !ii = !eq + 1
    !kk = @instr(%vline,"sector_")
    if !kk = 0 then
      !kk = @instr(%vline,"X.")
      !jj = !kk - 1 - !ii
      else
      !jj = !kk - 7 - !ii
      endif
    %desc = @rtrim(@mid(%vline,!ii,!jj))
    exitloop
    endif
  next
endsub
```

Defines:
find_var_description, used in chunk 194.

6.4.15 srcEview/frbus.package/programs/stochsim.prg

197 ⟨*srcEview/frbus.package/programs/stochsim.prg* 197⟩≡
⟨*stochastic simulations under variable expectations* 198⟩

```
'*************************************************************************
'*************************************************************************
'*************************************************************************
'*************************************************************************
'Subroutines


'*************************************************************************
'*************************************************************************
```
⟨*form table* 207⟩

```
'*************************************************************************
'*************************************************************************
```
⟨*make statistics* 208⟩

This code is written to file `srcEview/frbus.package/programs/stochsim.prg`.
Defines:
`stochsim`, used in chunk 168.

198 ⟨*stochastic simulations under variable expectations* 198⟩≡ (197)

```
' Program for stochastic sims under VAR expectations

' The stochastic shocks are bootstrapped from the de-meaned
' historical errors of stochastic equations.  The parameters
' %residstart and %residend declare the historical error range.
' A list of stochastic equations is extracted from the file
' pointed to by %varinfo.

' The bootstrap procedure randomly draws one historical quarter
' at a time when the parameter %errorblock = 1; alternatively, if
' %errorblock = 2, then the procedure would randomly draw two
' successive quarters at a time.

' The stochastic replications are simulated in a simple loop,
' rather than using the built-in EViews stochastic simulation
' procedure, so that shocks in the first simulation quarter can
' be scaled down by the parameter %q1_shock_damp.  This feature
' is useful when uncertainty about the first simulation quarter
' in real-time analysis by known information.  The shocks are
' not rescaled when %q1_shock_damp = 1.

' Similarly, the parameter %rff_weight_q1 is also designed to be
' used in real-time analysis when the first simulation quarter
' corresponds to a quarter that is already under way.  The
' parameter provides the fractional value to be given to the
' monetary policy rule; the remaining fractional value is given to
' an exogenous value.

' The document Simulation Basics discusses the effects of
' imposing the zero lower bound (ZLB) on the federal funds rate
' (%zerobound parameter) and imposing threshold conditions
' on the liftoff of the funds rate from a ZLB episode
' (%threshold parameter).

' ************************************************************
' Initial filename and parameter settings
' ************************************************************

' Subroutines
include ../subs/master_library

' Workfile
%wfstart = "1965q1"
%wfend = "2020q4"
%mainpage = "main"
```

```
    wfcreate(wf=aaa,page={%mainpage}) q {%wfstart} {%wfend}

  ' FRB/US model name and location
    %varmod = "stdver"
    %varpath = "../mods/"
    %varinfo = "../mods/stdver_varinfo"

  ' Input database
    %dbin  = "../data/longbase"

  ' Simulation range
    %simstart = "2014q1"
    %simend   = "2018q4"

  ' Stochastic parameters
    rndseed 12345
    %errorblock = "1"
    %residstart = "1970q1"
    %residend   = "2012q4"
    %nsims      = "1000"
    %q1_shock_damp = ".5"
    %dbout_series = "rff lur picxfe picnia picx4 xgap2 hggdp anngr"

  ' Monetary policy
    %zerobound  = "yes"
    %threshold  = "yes"
    %rff_weight_q1  = ".25"

  ' ***************************************************************
  ' Retrieve data, model equations and coefficients, set
  ' policy options, and compute tracking residuals
  ' ***************************************************************

  ' Load equations, coefficients, and variable information
    ld_frbus_eqs(modelname=%varmod,modelpath=%varpath)
    ld_frbus_cfs(modelname=%varmod,modelpath=%varpath)
    ld_varinfo(pathname=%varinfo)

  ' add 4-qtr gdp growth equation
    {%varmod}.append anngr - anngr_aerr = 100*((xgdp/xgdp(-4))-1)

  ' Load data
    dbopen %dbin as longbase
    fetch(d=longbase) *
    smpl @all
    series anngr = 100*((xgdp/xgdp(-4))-1)
```

```
' Set monetary policy to inertial Taylor rule (dmpintay, rffintay)
smpl @all
call set_mp("dmpintay")
if %zerobound = "yes" then
  rffmin = .250
  else
  rffmin = -9999
  endif
if %threshold = "yes" and %zerobound = "no" then
  %err = "Error: policy threshold conditions can only be used when the ZLB is impos
  @uiprompt(%err)
  stop
  endif
if %threshold = "yes" and %zerobound = "yes" then
  dmptrsh = 1
  dmptr = 0
  else
  dmptrsh = 0
  endif
drstar = 0

smpl {%simstart} {%simstart}
dmpintay = @val(%rff_weight_q1)
dmpex = 1 - dmpintay

' Set fiscal policy
smpl @all
call set_fp("dfpex")

dmpstb = 1

' Set _aerr variables to zero
smpl @all
{%varmod}.makegroup(a,n) endog @endog
call groupnew("endog","_aerr")
call group2zero("endog_aerr")

' Standard solution options
{%varmod}.solveopt(o=b,g=14,z=1e-14)

' Assign baseline tracking add factors
%suftrk = "_0"
smpl %residstart %simend
{%varmod}.addassign @all
{%varmod}.addinit(v=n) @all
```

```
    {%varmod}.scenario(n,a={%suftrk}) "track"
    {%varmod}.solve
    scalar mm = @max(@abs(xgap{%suftrk}-xgap))
    if mm > .0001 then
      statusline dynamic tracking simulation failed for {%varmod}
      stop
      endif

  ' ***************************************************************
  ' More monetary policy settings
  ' ***************************************************************


  ' if policy thresholds are turned on, set add factors on endogenous
  ' threshold switch variables to zero
    if %threshold = "yes" then
      smpl @all
      dmptpi_a = 0
      dmptlur_a = 0
      dmptmax_a = 0
      dmptr_a = 0
      endif

  ' if the zero bound is binding in part or all of the baseline, the
  ' adds (_a) on the policy rule and the funds rate equations are
  ' determined so as to satisfy the following conditions.
  '
  ' a.  the stochastic funds rate equals the maximum of the zero bound and
  '     the prediction of the chosen policy rule (this simply requires that
  '     rffe_a and rffe_aerr be zero)
  ' b.  the prediction of the chosen policy rule is subject to _a add factors
  '     that are determined as follows:
  '     (1) in quarters when the zero bound is not binding in the baseline,
  '         the associated add factors equal the values that make
  '         the policy rule equation match the baseline funds rate under
  '         baseline conditions (this is satisfied by the tracking adds on
  '         the policy rule as long as the baseline value of the policy rule
  '         variable equals the baseline funds rate);
  '     (2) in quarters when the zero bound is binding in the baseline,
  '         the associated add factors are determined by linear interpolation
  '         of the add factors generated according to b(1) for the
  '         unbound quarters;
  '     (3) when the zero bound is binding in all baseline quarters, the
  '         policy rule add factors are zero;
  '     (4) the zero bound is assumed to be binding in the baseline whenever
  '         the baseline funds rate (rffe) is within 25 basis points of the
```

```
' zero bound variable (rffmin).

smpl %simstart %simend
series not_constrnd = ((rffe - rffmin) >= .25)
!tmp_max = @max(not_constrnd)
!tmp_min = @min(not_constrnd)

' zero bound binding in some quarters
if (!tmp_max = 1) and (!tmp_min = 0) then
  smpl %simstart %simend
  rffe_a = 0
  rffe_aerr = 0
  rffintay_aerr = 0
  smpl %simstart %simend if (not_constrnd = 0)
  rffintay_a = NA
  %series_in = "rffintay_a"
  %series_out = %series_in + "_int"
  call interp_lin(%series_in,%series_out,%simstart,%simend)
  rffintay_a = {%series_out}
  endif

' zero bound binding in all quarters
if (!tmp_max = 0) and (!tmp_min = 0) then
  smpl %simstart %simend
  rffe_a = 0
  rffe_aerr = 0
  rffintay_aerr = 0
  rffintay_a = 0
  endif

' ****************************************************************
' Stochastic shocks
' ****************************************************************

' copy historical residuals into series whose names have _err suffixes
smpl %residstart %residend
copy *_a *_err

' use vinfo table to create list/group of equations to receive shocks
%tmp = " "
for !i = 1 to vinfo_size
  %vname = @word(vinfo_vname,!i)
  %stoch = @word(vinfo_stoch,!i)
  if %stoch <> "NO" then
    %tmp = %tmp + " " + %vname
    endif
```

```
    next
  group shock {%tmp}

' demean historical residuals and store them in a matrix

  smpl %residstart %residend
  %error_names = " "
  for !i = 1 to shock.@count
    %temp = shock.@seriesname(!i) + "_err"
    scalar mm = @mean({%temp})
      series {%temp} =  {%temp} - mm
      %error_names = %error_names + " " + %temp
      next

  group errors {%error_names}
  smpl %residstart %residend
  stom(errors,errormat)

' create table of error statistics
  !nrows = 3 + errors.@count
  !ncols = 3
  table(!nrows,!ncols) error_tab
  error_tab.setjust(r1c1:r{!nrows}c1) left
  error_tab.setwidth(1) 20
  error_tab(1,1) = "error"
  error_tab(1,2) = "mean"
  error_tab(1,3) = "std-dev"
  smpl %residstart %residend
  for !i = 1 to errors.@count
    series tseries = errors(!i)
    error_tab(!i+3,1) = errors.@seriesname(!i)
    error_tab(!i+3,2) = @mean(tseries)
    error_tab(!i+3,3) = @stdev(tseries)
    next

' miscellaneous

  smpl %simstart %simend
  scalar nqtrs = @obssmpl
  scalar nrepl = {%nsims}
  scalar nsims = {%nsims}
  scalar nerrors = @rows(errormat)
  scalar bbbb = nqtrs-nerrors

  call groupnew("shock","_aerr")
```

```
  group track {%dbout_series}
  call groupnames2string("track",%tracknames)

' for tracked variables, set up matrices to hold stochastic results
  for !i = 1 to track.@count
    %temp = track.@seriesname(!i)
    matrix(nqtrs,nrepl) {%temp}_mat
    next


' ***************************************************************
' Stochastic sims
' ***************************************************************

  %sufstoch = "_1"
  {%varmod}.scenario(n,a={%sufstoch}) "stoch sims"


' ********************************************
' stochastic simulation loop (sims are run one at a time)

  smpl %simstart %simend
  for !i = 1 to nrepl
    statusline running stochastic sim number  !i
  ' draw nqtrs random rows from the matrix of historical errors,
  ' damp the shocks in the first drawn row, and load the shocks
  ' into the respective  _aerr error series
    matrix stocherrors = @resample(errormat,bbbb,{%errorblock})
    for !j = 1 to @columns(stocherrors)
      stocherrors(1,!j) = @val(%q1_shock_damp) * stocherrors(1,!j)
      next
    mtos(stocherrors,shock_aerr)
    {%varmod}.solve
  ' store solution values
    for !j = 1 to track.@count
      %temp = track.@seriesname(!j)
      %temp1 = %temp + "_mat"
      stom({%temp}{%sufstoch},tmp)
      colplace({%temp1},tmp,!i)
      next
    next

' ***************************************************************
' Statistics
' ***************************************************************
```

```
    statusline computing statistics

    smpl %simstart %simend
    !index = 2
    series year = @year
    series quarter = @quarter
    alpha yyyyqq = @str(year) + "Q" + @str(quarter)
    !lqtr = @dtoo(%simstart) - 1
    !nstats = 8

  'create a summary table in which to store key results

    call tableform("summary_tab","100")

  ' loop over each tracked variable,
    for !ii1 = 1 to track.@count
      %trkname = track.@seriesname(!ii1)
    ' compute statistics
      call makestats(%trkname)

    ' load statistics into variable-specific table
      %tabname = %trkname + "_tab"
      call tableform(%tabname,@str(nqtrs+2))
      for !ii2 = 1 to nqtrs
        {%trkname}_tab(!ii2+2,1) = yyyyqq(!lqtr + !ii2)
        for !ii3 = 1 to !nstats
          {%trkname}_tab(!ii2+2,!ii3+1) = {%trkname}_stats(!ii2,!ii3)
          next
        next

    ' load statistics for each q4 observation into summary table
      !index = !index + 1
      summary_tab(!index,1) = %trkname
      !index = !index + 1
      for !ii2 = 1 to nqtrs
        if quarter(!lqtr+!ii2) = 4 then
          for !ii3 = 1 to !nstats + 1
            summary_tab(!index,!ii3) = {%trkname}_tab(!ii2+2,!ii3)
            next
          !index = !index + 1
          endif
        next

    ' make graph showing 70 and 90 percent bands
      graph {%trkname}_graph.band {%trkname}_lo90 {%trkname}_hi90 {%trkname}_lo70 _
          {%trkname}_hi70 {%trkname}_base
```

```
    {%trkname}_graph.addtext(t) %trkname
    {%trkname}_graph.options size(6,4.5)

  next


' ************************************
' summary graph

  lur_graph.addtext(t,just(c),font("arial",12)) Unemployment Rate
  rff_graph.addtext(t,just(c),font("arial",12)) Federal Funds Rate
  picx4_graph.addtext(t,just(c),font("arial",12)) 4-qtr Core Inflation Rate
  anngr_graph.addtext(t,just(c),font("arial",12)) 4-qtr Real GDP Growth Rate
  lur_graph.legend -display
  rff_graph.legend -display
  picx4_graph.legend -display
  anngr_graph.legend -display

  graph summary_graph.merge lur_graph rff_graph picx4_graph anngr_graph
  summary_graph.legend -display
  summary_graph.addtext(t,just(c),font("Arial",16)) Stochastic Simulations\r(70 and 9
  show summary_graph


' ************************************
' summary spool
  spool results
  summary_tab.deleterow(!index) 100
  results.append summary_tab
  results.append summary_graph
  results.append error_tab
  results.display
```

Uses group2zero 81a, groupnames2string 81b, groupnew 82, interp_lin 83, ld_frbus_cfs 169a 169b, ld_frbus_eqs 170b 171, ld_varinfo 184 185, makestats 208, set_fp 84, set_mp 85a, and tableform 207.

207 ⟨*form table* 207⟩≡ (197)

```
subroutine tableform(string %tabname, string %nrows)

  table(@val(%nrows),9) {%tabname}

  {%tabname}.setwidth(1:9) 8
  {%tabname}.setjust(r1c1:r{%nrows}c9) right
  {%tabname}.setformat(r2c2:r{%nrows}c9) f.3
  {%tabname}(1,1) = "qtr"
  {%tabname}(1,2) = "baseline"
  {%tabname}(1,3) = "mean"
  {%tabname}(1,4) = "median"
  {%tabname}(1,5) = "stdev"
  {%tabname}(1,6) = "90%-low"
  {%tabname}(1,7) = "90%-hi"
  {%tabname}(1,8) = "70%-low"
  {%tabname}(1,9) = "70%-hi"

  endsub
```

Defines:
`tableform`, used in chunk 198.

208 ⟨*make statistics* 208⟩≡ (197)

```
subroutine makestats(string %trkname)

  %trkmat = %trkname + "_mat"
  %statsmat = %trkname + "_stats"
  matrix(nqtrs,8) {%statsmat}

  smpl {%simstart} {%simend}

' loop over each simulation quarter
  for !ii2 = 1 to nqtrs
  ' put simulation replications for this quarter into matrix tempm1
    matrix tempm1 = @sort(@rowextract({%trkmat},!ii2))
    {%statsmat}(!ii2,1) = {%trkname}(!lqtr + !ii2)
    {%statsmat}(!ii2,2) = @mean(tempm1)
    {%statsmat}(!ii2,3) = tempm1(1,@floor(.50*nrepl))
    {%statsmat}(!ii2,4) = @stdev(tempm1)
    {%statsmat}(!ii2,5) = tempm1(1,@floor(.05*nrepl))
    {%statsmat}(!ii2,6) = tempm1(1,@floor(.95*nrepl))
    {%statsmat}(!ii2,7) = tempm1(1,@floor(.15*nrepl))
    {%statsmat}(!ii2,8) = tempm1(1,@floor(.85*nrepl))

    next

' also create individual series for each statistic
  series {%trkname}_base = 0
  series {%trkname}_mn = 0
  series {%trkname}_med  = 0
  series {%trkname}_se  = 0
  series {%trkname}_lo90 = 0
  series {%trkname}_hi90 = 0
  series {%trkname}_lo70 = 0
  series {%trkname}_hi70 = 0

  group {%trkname}_group {%trkname}_base {%trkname}_mn {%trkname}_med _
        {%trkname}_se {%trkname}_lo90 {%trkname}_hi90 {%trkname}_lo70 _
        {%trkname}_hi70
  mtos({%statsmat},{%trkname}_group)

  endsub
```

Defines:
makestats, used in chunk 198.

6.4.16 srcEview/frbus.package/subs/master.library.prg

209a ⟨*srcEview/frbus.package/subs/master.library.prg* 209a⟩≡
⟨*master library routines* 209b⟩

This code is written to file `srcEview/frbus.package/subs/master.library.prg`.

209b ⟨*master library routines* 209b⟩≡ (209a)

```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*quarterly date string shift* 79⟩

```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*copy series into group* 80⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*set group to zero* 81a⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*names of all series in group* 81b⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*create new group* 82⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*interpolate unavailable observations* 83⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*set fiscal policy option* 84⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*set monetary policy option* 85a⟩
```
'*******************************************************************************
'*******************************************************************************
'*******************************************************************************
```
⟨*set monetary policy fed funds rate* 85b⟩

6.4.17 srcEview/frbus.package/subs/mce.solve.library.prg

210 ⟨*srcEview/frbus.package/subs/mce.solve.library.prg* 210⟩≡
⟨*mce solve library* 211⟩

This code is written to file `srcEview/frbus.package/subs/mce.solve.library.prg`.
Defines:
`mce_solve_library`, used in chunks 7, 17, 23, 31, 41, 44, 47, 51, 54, and 168.

211 ⟨*mce solve library* 211⟩≡ (210 215a)
⟨*mce solve library change history* 86⟩

```
' ********************************************************************* '
' ********************************************************************* '
' *********************************************************************
```
⟨*run model consistent expectations* 88⟩

```
'*************************************************************************
'*************************************************************************
'*************************************************************************
```
⟨*determine endogenous and exogenous variables* 95⟩

```
' ********************************************************************* '
' ********************************************************************* '
' *********************************************************************
```
⟨*determine default method, linesearch, and other options* 98⟩

```
' ************************************************************
' ************************************************************
' ************************************************************
```
⟨*parse options containing equal signs* 102a⟩

```
' ************************************************************
' ************************************************************
' ************************************************************
```
⟨*parse options not containing equal signs* 102b⟩

```
' ************************************************************************
' ************************************************************************
' ************************************************************************
' ************************************************************************
```
⟨*create common variables, strings, matrices, vectors, and tables* 103⟩

```
' ********************************************************************* '
' ********************************************************************* '
' *********************************************************************
```
⟨*model consistent coefficient simulation* 105⟩

```
'*****************************************************************
'*****************************************************************
'*****************************************************************
```
⟨*solve model consistent instrument values* 114⟩

```
'*****************************************************************
'*****************************************************************
'*****************************************************************
```
⟨*compute derivatives of mce targets wrt mce instruments* 116⟩

```
'*************************************************************
'*************************************************************
'*************************************************************
```
⟨*model consistent coefficient non-monotone step-length procedure* 122⟩

```
'*************************************************************
'*************************************************************
'*************************************************************
```
⟨*model consistent armijo optimization rule* 124⟩

```
'*************************************************************************************
'*************************************************************************************
'*************************************************************************************
```
⟨*variable terminal values* 125⟩

```
'*************************************************************************************
'*************************************************************************************
'*************************************************************************************
```

⟨*set options based on defaults and overrides* 127⟩

```
'*************************************************************************************
'*************************************************************************************
'*************************************************************************************
```

⟨*main unconstrained optimal control simulation* 134⟩

```
'*************************************************************************
'*************************************************************************
'*************************************************************************
```
⟨*main optimal control simulation with inequality constraints* 138⟩

```
'*************************************************************************
'*************************************************************************
'*************************************************************************
```
⟨*model consistent optimal time-consistent solution* 143⟩

```
'*************************************************************************
'*************************************************************************
'*************************************************************************
```
⟨*compute derivatives of loss function targets wrt instruments* 151⟩

```
'*****************************************************************
'*****************************************************************
'*****************************************************************
```
⟨*solve model consistent expectations model* 153⟩

```
'*****************************************************************
'*****************************************************************
'*****************************************************************
```
⟨*convert mcz inequality constraints* 155⟩

```
'*************************************************************
'*************************************************************
'*************************************************************
```
⟨*shift left* 158⟩

```
'*************************************************************
'*************************************************************
'*************************************************************
```
⟨*find next delimiter* 159⟩

```
' ********************************************************************* '
' ********************************************************************* '
' *********************************************************************
```
⟨*load frbus with transformed subsidiary model* 160⟩

```
' ********************************************************************* '
' ********************************************************************* '
' *********************************************************************
```
⟨*create wage and expectation variables in forward looking model* 164⟩

6.5 mce solve package

6.5.1 srcEview/mce.solve.package/example1.prg

214a ⟨*srcEview/mce.solve.package/example1.prg* 214a⟩≡
⟨*mce example1* 41⟩
This code is written to file `srcEview/mce.solve.package/example1.prg`.

6.5.2 srcEview/mce.solve.package/example2.prg

214b ⟨*srcEview/mce.solve.package/example2.prg* 214b⟩≡
⟨*mce example2* 44⟩
This code is written to file `srcEview/mce.solve.package/example2.prg`.

6.5.3 srcEview/mce.solve.package/example3.prg

214c ⟨*srcEview/mce.solve.package/example3.prg* 214c⟩≡
⟨*mce example3* 47⟩
This code is written to file `srcEview/mce.solve.package/example3.prg`.

6.5.4 srcEview/mce.solve.package/example4.prg

214d ⟨*srcEview/mce.solve.package/example4.prg* 214d⟩≡
⟨*mce example4* 51⟩
This code is written to file `srcEview/mce.solve.package/example4.prg`.

6.5.5 srcEview/mce.solve.package/example5.prg

214e ⟨*srcEview/mce.solve.package/example5.prg* 214e⟩≡
⟨*mce example5* 54⟩
This code is written to file `srcEview/mce.solve.package/example5.prg`.

6.5.6 srcEview/mce.solve.package/mce.solve.library.prg

215a ⟨*srcEview/mce.solve.package/mce.solve.library.prg* 215a⟩≡
⟨*mce solve library* 211⟩

This code is written to file `srcEview/mce.solve.package/mce.solve.library.prg`.
Defines:
`mce_solve_library`, used in chunks 7, 17, 23, 31, 41, 44, 47, 51, 54, and 168.

6.6 state space package

6.6.1 srcEview/state.space.package/data.transformations.prg

215b ⟨*srcEview/state.space.package/data.transformations.prg* 215b⟩≡
⟨*data transformations* 63⟩

This code is written to file `srcEview/state.space.package/data.transformations.prg`.

6.6.2 srcEview/state.space.package/estimation.code.prg

215c ⟨*srcEview/state.space.package/estimation.code.prg* 215c⟩≡
⟨*estimation code* 66⟩

This code is written to file `srcEview/state.space.package/estimation.code.prg`.

6.6.3 srcEview/state.space.package/frbus.supply.estimation.prg

215d ⟨*srcEview/state.space.package/frbus.supply.estimation.prg* 215d⟩≡
⟨*estimation model* 59⟩

This code is written to file `srcEview/state.space.package/frbus.supply.estimation.prg`.

6.6.4 srcEview/state.space.package/frbus.supply.filter.prg

215e ⟨*srcEview/state.space.package/frbus.supply.filter.prg* 215e⟩≡
⟨*supply filter* 70⟩

This code is written to file `srcEview/state.space.package/frbus.supply.filter.prg`.

6.6.5 srcEview/state.space.package/initial.values.prg

215f ⟨*srcEview/state.space.package/initial.values.prg* 215f⟩≡
⟨*initial values* 73⟩

This code is written to file `srcEview/state.space.package/initial.values.prg`.

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