

```

1  clear all
2  close all
3
4  % set parameters
5  beta = 0.995;
6  kappa = 1-40^(-1);
7  spF = 0.03;
8  spB = 0.01;
9  psi = 0.81;
10 epsip = 11;
11 epsiw = 11;
12 alpha = 1/3;
13 delta0 = 0.025;
14 g = 0.2;
15 bb = 0.8;
16 bcs = 0.1; % central bank balance sheet / Y
17 bcbGs = 0.9; % percentage of balance sheet holding government bonds
18 by = 0.5; % steady state government debt / GDP
19 levs = 5;
20 sigma = 0.95;
21
22 % solve for steady state
23 Rds = beta^(-1);
24 RFs = (1+spF)^(1/4)*Rds;
25 RBs = (1+spB)^(1/4)*Rds;
26 Qs = (RFs - kappa)^(-1);
27 QBs = (RBs - kappa)^(-1);
28 M1s = beta/(Qs*(1-beta*kappa));
29 M2s = 1 + (M1s-1)*psi;
30 pws = (epsip-1)/epsip;
31 Ks = (alpha*pws/(M2s*(1/beta - (1-delta0))))^(1/(1-alpha));
32 Ys = Ks^(alpha);
33 Is = delta0*Ks;
34 ws = (1-alpha)*pws*Ks^(alpha);
35 delta1 = (alpha*pws*Ks^(alpha-1)/M2s);
36 Cs = (1-g)*Ys - Is;
37 mus = (1/Cs)*(1-beta*bb)/(1-bb);
38 mrss = ((epsiw-1)/epsiw)*ws;
39 chi = mus*mrss;
40 fws = psi*Is/(Qs*(1-kappa));
41 res = bcs*Ys;
42 bcbs = bcbGs*res/QBs;
43 fcbs = (res - QBs*bcbs)/Qs;
44 fs = fws - fcbs;
45 bGs = by*Ys/QBs;
46 bs = bGs - bcbs;
47 ns = (Qs*fs + QBs*bs + res)/levs;
48 ds = Qs*fs + QBs*bs + res - ns;
49 Delta = (RBs - Rds)/(RFs - Rds);
50 phis = (Qs*fs + Delta*QBs*bs)/ns;
51 thetas = (1 - sigma + phis*beta*(1-sigma)*(RFs - Rds))/((1-sigma)*phis -
beta*sigma*phis^2*(RFs - Rds));
52 X = ns - sigma*( (RFs-Rds)*Qs*fs + (RBs - Rds)*QBs*bs + Rds*ns);
53 Omegas = 1 - sigma + sigma*phis*thetas;
54 lams = (thetas/(beta*(RFs - Rds)*(1-sigma + sigma*phis*thetas)) - 1)^(-1);
55
56 % parameters unrelated to steady state
57 phip = 0.75;
58 phiw = 0.75;
59 psik = 2; % capital adjustment cost
60 delta2 = 0.01; % squared term capital adjustment cost
61 eta = 1; % Frisch elasticity
62
63 % Taylor rule
64 rhor = 0.8;
65 phipi = 1.5;
66 phiy = 0.15;
67 sr = 0.0025;
68

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69 % Shock processes
70 rhof = 0.97;
71 rhob = 0.97;
72 sf = 0.01;
73 sb = 0.01;
74 rhoA = 0.9;
75 sA = 0.01;
76 rhot = 0.95;
77 st = 0.01;
78 rhoG = 0.9;
79 sG = 0.01;
80 rhoB = 0.9;
81 sB = 0.9;
82
83 addpath('occbin_20140630\toolkit_files')
84 %addpath('functions')
85 nperiods=29;
86 maxiter=50;
87
88 modnam = 'sw_2020';
89 modnamstar = 'sw_2020_zlb';
90
91 constraint = 'Rre<-0.005';
92 constraint_relax = 'Rtr>-0.005';
93
94 save param_sw beta kappa spF spB psi epsip epsiw alpha delta0 g bb bcs bcbGs by levs
sigma Rds RFs RBs Qs QBs M1s M2s pws Ks Ys Is ws delta1 Cs mus mrss chi fws res bcbs
fcbs fs bGs bs ns ds Delta phis thetas X Omegas lams phip phiw psik delta2 eta rhor
hipi phiy sr rhof rhob sf sb rhoA sA rhot st rhoG sG rhoB sB
95
96 baseline1= zeros(10,3);
97
98 scenario= baseline1;
99 scenario(end,2) = 1;
100
101 baseline=baseline1;
102 baseline(1:9,1) = 25.5;
103
104
105 % do a credit shock under exogenous QE
106 % Do credit shocks
107 irfshock = char('et','et2'); % note extra shock that is the same to rig this to work
108
109 %%%%%%%%%%%%%% No ZLB
110 %%%%%%%%%%%%%%
111 % First time we solve simulation only with baseline shocks
112 [sim_MP] = ...
113     solve_one_constraint(modnam,modnamstar,...
114         constraint, constraint_relax,...
115         baseline,irfshock,nperiods,maxiter);
116
117 % Second time we solve simulation with baseline shocks and scenario
118 [sim_MP2] = ...
119     solve_one_constraint(modnam,modnamstar,...
120         constraint, constraint_relax,...
121         baseline+scenario,irfshock,nperiods,maxiter);
122 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
123
124 %%%%%%%%%%%%%% Impose ZLB
125 %%%%%%%%%%%%%%
126
127 shock_size = 1;
128 % First time we solve simulation only with baseline shocks
129 [~, sim_zlb] = ...
130     solve_one_constraint(modnam,modnamstar,...
131         constraint, constraint_relax,...
132         baseline,irfshock,nperiods,maxiter);
133
134 % Second time we solve simulation with baseline shocks and scenario

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135 [~, sim_zlb2] = ...
136     solve_one_constraint(modnam,modnamstar,...
137     constraint, constraint_relax,...
138     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
139
140 irf1 = sim_zlb2 - sim_zlb;
141
142 % Now do a credit shock under endogenous QE
143
144 modnam = 'sw_2020';
145 modnamstar = 'sw_2020_zlb_endo';
146
147 %%%%%%%%%%%%%%% No ZLB
148 %%%%%%%%%%%%%%%
149 % First time we solve simulation only with baseline shocks
150 [sim_MP] = ...
151     solve_one_constraint(modnam,modnamstar,...
152     constraint, constraint_relax,...
153     baseline,irfshock,nperiods,maxiter);
154
155 % Second time we solve simulation with baseline shocks and scenario
156 [sim_MP2] = ...
157     solve_one_constraint(modnam,modnamstar,...
158     constraint, constraint_relax,...
159     baseline+scenario,irfshock,nperiods,maxiter);
160 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
161
162 %%%%%%%%%%%%%%% Impose ZLB
163 %%%%%%%%%%%%%%%
164
165 shock_size = 1;
166 % First time we solve simulation only with baseline shocks
167 [~, sim_zlb] = ...
168     solve_one_constraint(modnam,modnamstar,...
169     constraint, constraint_relax,...
170     baseline,irfshock,nperiods,maxiter);
171
172 % Second time we solve simulation with baseline shocks and scenario
173 [~, sim_zlb2] = ...
174     solve_one_constraint(modnam,modnamstar,...
175     constraint, constraint_relax,...
176     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
177
178 irf2 = sim_zlb2 - sim_zlb;
179
180 T = size(irf1(10:end,1),1);
181 t = 1:T;
182
183 % variable positions
184 pY = 49; % note this is log
185 pC = 50;
186 pI = 51;
187 pL = 52;
188 pPi = 53;
189 pRd = 54;
190
191
192 figure
193 subplot(2,3,1)
194 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k',t,irf2(10:end,pY),'--b','Linewidth',1
195 .5)
196 title('Output')
197
198 subplot(2,3,2)
199 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k',t,irf2(10:end,pC),'--b','Linewidth',1
200 .5)
201 title('Consumption')

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202 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k',t,irf2(10:end,pI),'--b','Linewidth',1
    .5)
203 title('Investment')
204
205 subplot(2,3,4)
206 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k',t,irf2(10:end,pL),'--b','Linewidth',1
    .5)
207 title('Labor')
208
209 subplot(2,3,5)
210 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k',t,irf2(10:end,pPi),'--b','Linewidth
    ',1.5)
211 title('\pi')
212
213 subplot(2,3,6)
214 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k',t,irf2(10:end,pRd),'--b','Linewidth
    ',1.5)
215 title('r^{d}')
216
217
218 %%%%%%%%%%%%%%%%%%%%%%%%% government spending shock
219
220
221 modnam = 'sw_2020';
222 modnamstar = 'sw_2020_zlb';
223
224 constraint = 'Rre<-0.005';
225 constraint_relax = 'Rtr>-0.005';
226
227 save param_sw beta kappa spF spB psi epsip epsiw alpha delta0 g bb bcs bcbGs by levs
    sigma Rds RFs RBs Qs QBs M1s M2s pws Ks Ys Is ws delta1 Cs mus mrss chi fws res bcbs
    fcbs fs bGs bs ns ds Delta phis thetas X Omegas lams phip phiw psik delta2 eta rhor
    phipi phiy sr rhof rhob sf sb rhoA sA rhot st rhoG sG rhoB sB
228
229 baseline= zeros(10,3);
230
231 scenario= baseline;
232 scenario(end,2) = 1;
233
234 baseline=baseline;
235 baseline(1:9,1) = 25.5;
236
237
238 % do a government shock under exogenous QE
239 % Do credit shocks
240 irfshock = char('et','eG'); % note extra shock that is the same to rig this to work
241
242 %%%%%%%%%%%%%%%%%%%%%%%%% No ZLB
243 %%%%%%%%%%%%%%%%%%%%%%%%%
244 % First time we solve simulation only with baseline shocks
245 [sim_MP] = ...
246     solve_one_constraint(modnam,modnamstar,...
247     constraint, constraint_relax,...
248     baseline,irfshock,nperiods,maxiter);
249
250 % Second time we solve simulation with baseline shocks and scenario
251 [sim_MP2] = ...
252     solve_one_constraint(modnam,modnamstar,...
253     constraint, constraint_relax,...
254     baseline+scenario,irfshock,nperiods,maxiter);
255 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
256
257 %%%%%%%%%%%%%%%%%%%%%%%%% Impose ZLB
258 %%%%%%%%%%%%%%%%%%%%%%%%%
259
260 shock_size = 1;
261 % First time we solve simulation only with baseline shocks
262 [~, sim_zlb] = ...
263     solve_one_constraint(modnam,modnamstar,...

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264     constraint, constraint_relax,...
265     baseline,irfshock,nperiods,maxiter);
266
267 % Second time we solve simulation with baseline shocks and scenario
268 [~, sim_zlb2] = ...
269     solve_one_constraint(modnam,modnamstar,...
270     constraint, constraint_relax,...
271     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
272
273 irf1 = sim_zlb2 - sim_zlb;
274
275 % Now do a credit shock under endogenous QE
276
277 modnam = 'sw_2020';
278 modnamstar = 'sw_2020_zlb_endo';
279
280 %%%%%%%%%%%%%%% No ZLB
281 %%%%%%%%%%%%%%%
282 % First time we solve simulation only with baseline shocks
283 [sim_MP] = ...
284     solve_one_constraint(modnam,modnamstar,...
285     constraint, constraint_relax,...
286     baseline,irfshock,nperiods,maxiter);
287
288 % Second time we solve simulation with baseline shocks and scenario
289 [sim_MP2] = ...
290     solve_one_constraint(modnam,modnamstar,...
291     constraint, constraint_relax,...
292     baseline+scenario,irfshock,nperiods,maxiter);
293 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
294
295 %%%%%%%%%%%%%%% Impose ZLB
296 %%%%%%%%%%%%%%%
297
298 shock_size = 1;
299 % First time we solve simulation only with baseline shocks
300 [~, sim_zlb] = ...
301     solve_one_constraint(modnam,modnamstar,...
302     constraint, constraint_relax,...
303     baseline,irfshock,nperiods,maxiter);
304
305 % Second time we solve simulation with baseline shocks and scenario
306 [~, sim_zlb2] = ...
307     solve_one_constraint(modnam,modnamstar,...
308     constraint, constraint_relax,...
309     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
310
311 irf2 = sim_zlb2 - sim_zlb;
312
313 T = size(irf1(10:end,1),1);
314 t = 1:T;
315
316 % variable positions
317 pY = 49; % note this is log
318 pC = 50;
319 pI = 51;
320 pL = 52;
321 pPi = 53;
322 pRd = 54;
323
324
325 figure
326 subplot(2,3,1)
327 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k',t,irf2(10:end,pY),'--b','Linewidth',1
328 .5)
329 title('Output')
330
331 subplot(2,3,2)
332 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k',t,irf2(10:end,pC),'--b','Linewidth',1

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.5)
332 title('Consumption')
333
334 subplot(2,3,3)
335 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k',t,irf2(10:end,pI),'--b','Linewidth',1
.5)
336 title('Investment')
337
338 subplot(2,3,4)
339 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k',t,irf2(10:end,pL),'--b','Linewidth',1
.5)
340 title('Labor')
341
342 subplot(2,3,5)
343 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k',t,irf2(10:end,pPi),'--b','Linewidth
',1.5)
344 title('\pi')
345
346 subplot(2,3,6)
347 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k',t,irf2(10:end,pRd),'--b','Linewidth
',1.5)
348 title('r^{d}')
349
350
351
352
353 %%%%%%%%%%%%%%%%%%%%%%%%%% productivity shock
354
355
356 modnam = 'sw_2020';
357 modnamstar = 'sw_2020_zlb';
358
359 constraint = 'Rre<-0.005';
360 constraint_relax = 'Rtr>-0.005';
361
362 save param_sw beta kappa spF spB psi epsip epsiw alpha delta0 g bb bcs bcbGs by levs
sigma Rds RFs RBs Qs QBs M1s M2s pws Ks Ys Is ws delta1 Cs mus mrss chi fws res bcbs
fcbs fs bGs bs ns ds Delta phis thetas X Omegas lams phip phiw psik delta2 eta rhor
phipi phiy sr rhof rhob sf sb rhoA sA rhot st rhoG sG rhoB sB
363
364 baseline1= zeros(10,3);
365
366 scenario= baseline1;
367 scenario(end,2) = 1;
368
369 baseline=baseline1;
370 baseline(1:9,1) = 25.5;
371
372
373 % do a productivity shock under exogenous QE
374 % Do credit shocks
375 irfshock = char('et','eA'); % note extra shock that is the same to rig this to work
376
377 %%%%%%%%%%%%%%%%%%%%%%%%%% No ZLB
378 %%%%%%%%%%%%%%%%%%%%%%%%%%
379 % First time we solve simulation only with baseline shocks
380 [sim_MP] = ...
381     solve_one_constraint(modnam,modnamstar,...
382     constraint, constraint_relax,...
383     baseline,irfshock,nperiods,maxiter);
384
385 % Second time we solve simulation with baseline shocks and scenario
386 [sim_MP2] = ...
387     solve_one_constraint(modnam,modnamstar,...
388     constraint, constraint_relax,...
389     baseline+scenario,irfshock,nperiods,maxiter);
390 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
391
392 %%%%%%%%%%%%%%%%%%%%%%%%%% Impose ZLB

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393 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
394
395 shock_size = 1;
396 % First time we solve simulation only with baseline shocks
397 [~, sim_zlb] = ...
398     solve_one_constraint(modnam,modnamstar,...
399     constraint, constraint_relax,...
400     baseline,irfshock,nperiods,maxiter);
401
402 % Second time we solve simulation with baseline shocks and scenario
403 [~, sim_zlb2] = ...
404     solve_one_constraint(modnam,modnamstar,...
405     constraint, constraint_relax,...
406     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
407
408 irf1 = sim_zlb2 - sim_zlb;
409
410 % Now do a credit shock under endogenous QE
411
412 modnam = 'sw_2020';
413 modnamstar = 'sw_2020_zlb_endo';
414
415 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% No ZLB
416 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
417 % First time we solve simulation only with baseline shocks
418 [sim_MP] = ...
419     solve_one_constraint(modnam,modnamstar,...
420     constraint, constraint_relax,...
421     baseline,irfshock,nperiods,maxiter);
422
423 % Second time we solve simulation with baseline shocks and scenario
424 [sim_MP2] = ...
425     solve_one_constraint(modnam,modnamstar,...
426     constraint, constraint_relax,...
427     baseline+scenario,irfshock,nperiods,maxiter);
428 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
429
430 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Impose ZLB
431 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
432
433 shock_size = 1;
434 % First time we solve simulation only with baseline shocks
435 [~, sim_zlb] = ...
436     solve_one_constraint(modnam,modnamstar,...
437     constraint, constraint_relax,...
438     baseline,irfshock,nperiods,maxiter);
439
440 % Second time we solve simulation with baseline shocks and scenario
441 [~, sim_zlb2] = ...
442     solve_one_constraint(modnam,modnamstar,...
443     constraint, constraint_relax,...
444     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
445
446 irf2 = sim_zlb2 - sim_zlb;
447
448 T = size(irf1(10:end,1),1);
449 t = 1:T;
450
451 % variable positions
452 pY = 49; % note this is log
453 pC = 50;
454 pI = 51;
455 pL = 52;
456 pPi = 53;
457 pRd = 54;
458
459
460 figure
461 subplot(2,3,1)

```

```
462 plot(t, irf0(10:end, pY), '-k', t, irf1(10:end, pY), '--k', t, irf2(10:end, pY), '--b', 'Linewidth', 1
.5)
463 title('Output')
464
465 subplot(2, 3, 2)
466 plot(t, irf0(10:end, pC), '-k', t, irf1(10:end, pC), '--k', t, irf2(10:end, pC), '--b', 'Linewidth', 1
.5)
467 title('Consumption')
468
469 subplot(2, 3, 3)
470 plot(t, irf0(10:end, pI), '-k', t, irf1(10:end, pI), '--k', t, irf2(10:end, pI), '--b', 'Linewidth', 1
.5)
471 title('Investment')
472
473 subplot(2, 3, 4)
474 plot(t, irf0(10:end, pL), '-k', t, irf1(10:end, pL), '--k', t, irf2(10:end, pL), '--b', 'Linewidth', 1
.5)
475 title('Labor')
476
477 subplot(2, 3, 5)
478 plot(t, irf0(10:end, pPi), '-k', t, irf1(10:end, pPi), '--k', t, irf2(10:end, pPi), '--b', 'Linewidth
', 1.5)
479 title('\pi')
480
481 subplot(2, 3, 6)
482 plot(t, irf0(10:end, pRd), '-k', t, irf1(10:end, pRd), '--k', t, irf2(10:end, pRd), '--b', 'Linewidth
', 1.5)
483 title('r^{d}')
484
```