

```

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
106 % Do private QE shocks
107 irfshock = char('et','ef');
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
141
142 irf1 = sim_zlb2 - sim_zlb;
143
144 T = size(irf1(10:end,1),1);
145 t = 1:T;
146
147 % variable positions
148 pY = 49; % note this is log
149 pC = 50;
150 pI = 51;
151 pL = 52;
152 pPi = 53;
153 pRd = 54;
154
155
156 figure
157 subplot(2,3,1)
158 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k','Linewidth',1.5)
159 title('Output')
160
161 subplot(2,3,2)
162 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k','Linewidth',1.5)
163 title('Consumption')
164
165 subplot(2,3,3)
166 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k','Linewidth',1.5)
167 title('Investment')
168
169 subplot(2,3,4)
170 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k','Linewidth',1.5)
171 title('Labor')
172
173 subplot(2,3,5)
174 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k','Linewidth',1.5)
175 title('\pi')
176
177 subplot(2,3,6)
178 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k','Linewidth',1.5)
179 title('r^{d}')
180
181
182
183
184 % Do government spending shocks
185 irfshock = char('et','eG');
186
187 %%%%%%%%%%%%%%% No ZLB
188 %%%%%%%%%%%%%%%
189 % First time we solve simulation only with baseline shocks
190 [sim_MP] = ...
191     solve_one_constraint(modnam,modnamstar,...
192     constraint, constraint_relax,...
193     baseline,irfshock,nperiods,maxiter);
194
195 % Second time we solve simulation with baseline shocks and scenario
196 [sim_MP2] = ...
197     solve_one_constraint(modnam,modnamstar,...
198     constraint, constraint_relax,...
199     baseline+scenario,irfshock,nperiods,maxiter);
200 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
201
202 %%%%%%%%%%%%%%% Impose ZLB
203 %%%%%%%%%%%%%%%

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204
205 shock_size = 1;
206 % First time we solve simulation only with baseline shocks
207 [~, sim_zlb] = ...
208     solve_one_constraint(modnam,modnamstar,...
209     constraint, constraint_relax,...
210     baseline,irfshock,nperiods,maxiter);
211
212 % Second time we solve simulation with baseline shocks and scenario
213 [~, sim_zlb2] = ...
214     solve_one_constraint(modnam,modnamstar,...
215     constraint, constraint_relax,...
216     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
217
218
219
220 irf1 = sim_zlb2 - sim_zlb;
221
222 T = size(irf1(10:end,1),1);
223 t = 1:T;
224
225 % variable positions
226 pY = 49; % note this is log
227 pC = 50;
228 pI = 51;
229 pL = 52;
230 pPi = 53;
231 pRd = 54;
232
233
234 figure
235 subplot(2,3,1)
236 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k','Linewidth',1.5)
237 title('Output')
238
239 subplot(2,3,2)
240 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k','Linewidth',1.5)
241 title('Consumption')
242
243 subplot(2,3,3)
244 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k','Linewidth',1.5)
245 title('Investment')
246
247 subplot(2,3,4)
248 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k','Linewidth',1.5)
249 title('Labor')
250
251 subplot(2,3,5)
252 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k','Linewidth',1.5)
253 title('\pi')
254
255 subplot(2,3,6)
256 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k','Linewidth',1.5)
257 title('r^{d}')
258
259
260 % Do credit shocks
261 irfshock = char('et','et2'); % note extra shock that is the same to rig this to work
262
263 %%%%%%%%%%%%%%% No ZLB
264 %%%%%%%%%%%%%%%
265 % First time we solve simulation only with baseline shocks
266 [sim_MP] = ...
267     solve_one_constraint(modnam,modnamstar,...
268     constraint, constraint_relax,...
269     baseline,irfshock,nperiods,maxiter);
270
271 % Second time we solve simulation with baseline shocks and scenario
272 [sim_MP2] = ...

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273     solve_one_constraint(modnam,modnamstar,...
274     constraint, constraint_relax,...
275     baseline+scenario,irfshock,nperiods,maxiter);
276 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
277
278 %%%%%%%%%%%%%%%%%%%%%%%%%% Impose ZLB
279 %%%%%%%%%%%%%%%%%%%%%%%%%%
280
281 shock_size = 1;
282 % First time we solve simulation only with baseline shocks
283 [~, sim_zlb] = ...
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_zlb2] = ...
290     solve_one_constraint(modnam,modnamstar,...
291     constraint, constraint_relax,...
292     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
293
294
295
296 irf1 = sim_zlb2 - sim_zlb;
297
298 T = size(irf1(10:end,1),1);
299 t = 1:T;
300
301 % variable positions
302 pY = 49; % note this is log
303 pC = 50;
304 pI = 51;
305 pL = 52;
306 pPi = 53;
307 pRd = 54;
308
309
310 figure
311 subplot(2,3,1)
312 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k','Linewidth',1.5)
313 title('Output')
314
315 subplot(2,3,2)
316 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k','Linewidth',1.5)
317 title('Consumption')
318
319 subplot(2,3,3)
320 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k','Linewidth',1.5)
321 title('Investment')
322
323 subplot(2,3,4)
324 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k','Linewidth',1.5)
325 title('Labor')
326
327 subplot(2,3,5)
328 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k','Linewidth',1.5)
329 title('\pi')
330
331 subplot(2,3,6)
332 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k','Linewidth',1.5)
333 title('r^{d}')
334
335 % Do productivity shocks
336 irfshock = char('et','eA');
337
338 %%%%%%%%%%%%%%%%%%%%%%%%%% No ZLB
339 %%%%%%%%%%%%%%%%%%%%%%%%%%
340 % First time we solve simulation only with baseline shocks
341 [sim_MP] = ...

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342     solve_one_constraint(modnam,modnamstar,...
343     constraint, constraint_relax,...
344     baseline,irfshock,nperiods,maxiter);
345
346 % Second time we solve simulation with baseline shocks and scenario
347 [sim_MP2] = ...
348     solve_one_constraint(modnam,modnamstar,...
349     constraint, constraint_relax,...
350     baseline+scenario,irfshock,nperiods,maxiter);
351 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
352
353 %%%%%%%%%%%%%%%%%%%%%%%%%% Impose ZLB
354 %%%%%%%%%%%%%%%%%%%%%%%%%%
355
356 shock_size = 1;
357 % First time we solve simulation only with baseline shocks
358 [~, sim_zlb] = ...
359     solve_one_constraint(modnam,modnamstar,...
360     constraint, constraint_relax,...
361     baseline,irfshock,nperiods,maxiter);
362
363 % Second time we solve simulation with baseline shocks and scenario
364 [~, sim_zlb2] = ...
365     solve_one_constraint(modnam,modnamstar,...
366     constraint, constraint_relax,...
367     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
368
369
370
371 irf1 = sim_zlb2 - sim_zlb;
372
373 T = size(irf1(10:end,1),1);
374 t = 1:T;
375
376 % variable positions
377 pY = 49; % note this is log
378 pC = 50;
379 pI = 51;
380 pL = 52;
381 pPi = 53;
382 pRd = 54;
383
384
385 figure
386 subplot(2,3,1)
387 plot(t,irf0(10:end,pY),'-k',t,irf1(10:end,pY),'--k','Linewidth',1.5)
388 title('Output')
389
390 subplot(2,3,2)
391 plot(t,irf0(10:end,pC),'-k',t,irf1(10:end,pC),'--k','Linewidth',1.5)
392 title('Consumption')
393
394 subplot(2,3,3)
395 plot(t,irf0(10:end,pI),'-k',t,irf1(10:end,pI),'--k','Linewidth',1.5)
396 title('Investment')
397
398 subplot(2,3,4)
399 plot(t,irf0(10:end,pL),'-k',t,irf1(10:end,pL),'--k','Linewidth',1.5)
400 title('Labor')
401
402 subplot(2,3,5)
403 plot(t,irf0(10:end,pPi),'-k',t,irf1(10:end,pPi),'--k','Linewidth',1.5)
404 title('\pi')
405
406 subplot(2,3,6)
407 plot(t,irf0(10:end,pRd),'-k',t,irf1(10:end,pRd),'--k','Linewidth',1.5)
408 title('r^{d}')
409
410 % Do public QE shocks

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411 irfshock = char('et','eb');
412
413 %%%%%%%%%%%%%% No ZLB
414 %%%%%%%%%%%%%%
415 % First time we solve simulation only with baseline shocks
416 [sim_MP] = ...
417     solve_one_constraint(modnam,modnamstar,...
418     constraint, constraint_relax,...
419     baseline,irfshock,nperiods,maxiter);
420
421 % Second time we solve simulation with baseline shocks and scenario
422 [sim_MP2] = ...
423     solve_one_constraint(modnam,modnamstar,...
424     constraint, constraint_relax,...
425     baseline+scenario,irfshock,nperiods,maxiter);
426 irf0 = sim_MP2 - sim_MP; % IRF with no Taylor rule
427
428 %%%%%%%%%%%%%% Impose ZLB
429 %%%%%%%%%%%%%%
430
431 shock_size = 1;
432 % First time we solve simulation only with baseline shocks
433 [~, sim_zlb] = ...
434     solve_one_constraint(modnam,modnamstar,...
435     constraint, constraint_relax,...
436     baseline,irfshock,nperiods,maxiter);
437
438 % Second time we solve simulation with baseline shocks and scenario
439 [~, sim_zlb2] = ...
440     solve_one_constraint(modnam,modnamstar,...
441     constraint, constraint_relax,...
442     baseline+scenario*shock_size,irfshock,nperiods,maxiter);
443
444
445
446 irf1 = 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','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','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','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','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','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','Linewidth',1.5)
483 title('r^{d}')
484
485
```