```
clear all
close all

% set parameters
sigma = 1; % inverse EIS
chi = 1; % inverse Frisch
beta = 0.99; % discount factor
phi = 0.75; % calvo parameters
zeta = ((1-phi)*(1-phi*beta))/phi; % slop coefficient in PC
psi = 0.2; % government spending share
rhoa = 0.9; % AR productivity
rhog = 0.9; % AR government spending
phipi = 1.5; % taylor rule coefficient
gamma = (chi*(1-psi)+sigma)/(1-psi);

% g shock
T = 20; % length of IRFs
H = 11; % period when ZLB lifts, peg lenfth is this minus 1
g_irf = zeros(T,1);
for j = 1:T
    g_irf(j,1) = rhog^(j-1);
end
rf_irf = -(sigma/(1-psi))*(psi*chi*(1-psi)/(chi*(1-psi)+sigma))*(rhog-1)*g_irf;

pi_irf = zeros(T,1);
x_irf = zeros(T,1);

% last period before liftoff
x_irf(H-1,1) = ((1-psi)/sigma)*rf_irf(H-1,1);
pi_irf(H-1,1) = gamma*zeta*x_irf(H-1,1);

% now iterate backwards
for j = 2:H-1
    x_irf(H-j,1) = x_irf(H-j+1,1) - ( (1-psi)/sigma )*(-pi_irf(H-j+1,1) - rf_irf(H-j));
    pi_irf(H-j,1) = gamma*zeta*x_irf(H-j,1) + beta*pi_irf(H-j+1,1);
end

i_irf = zeros(T,1);
for j = H:T
    i_irf(j,1) = rf_irf(j,1);
end

yf_irf = (psi*sigma/(chi*(1-psi)+sigma))*g_irf;
y_irf = x_irf + yf_irf;



% plot optimal and ZLB irfs
t = 1:T;

figure
subplot(2,3,1)
plot(g_irf,'-k','Linewidth',2)
title('g')

subplot(2,3,2)
plot(t,x_irf,'k',t,zeros(T,1),'--b','Linewidth',2)
title('x')

subplot(2,3,3)
plot(t,pi_irf,'k',t,zeros(T,1),'--b','Linewidth',2)
title('\pi')

subplot(2,3,4)
plot(t,i_irf,'k',t,rf_irf,'--b','Linewidth',2)
title('i')

subplot(2,3,5)
plot(t,(1/psi)*y_irf,'k',t,(1/psi)*yf_irf,'--b','Linewidth',2)
```

```
title('y')
legend('ZLB','No ZLB')


% a shock
a_irf = zeros(T,1);
for j = 1:T
    a_irf(j,1) = rhoa^(j-1);
end
rf_irf2 = (sigma/(1-psi))*( (1+chi)*(1-psi)/(chi*(1-psi)+sigma) )*(rhoa-1)*a_irf;

pi_irf2 = zeros(T,1);
x_irf2 = zeros(T,1);

% last period before liftoff
x_irf2(H-1,1) = ((1-psi)/sigma)*rf_irf2(H-1,1);
pi_irf2(H-1,1) = gamma*zeta*x_irf2(H-1,1);

% now iterate backwards
for j = 2:H-1
    x_irf2(H-j,1) = x_irf2(H-j+1,1) - ( (1-psi)/sigma )*(-pi_irf2(H-j+1,1) -
    rf_irf2(H-j));
    pi_irf2(H-j,1) = gamma*zeta*x_irf2(H-j,1) + beta*pi_irf2(H-j+1,1);
end

i_irf2 = zeros(T,1);
for j = H:T
    i_irf2(j,1) = rf_irf2(j,1);
end

yf_irf2 = ( (1+chi)*(1-psi)/(chi*(1-psi)+sigma) )*a_irf;
y_irf2 = x_irf2 + yf_irf2;

figure
subplot(2,3,1)
plot(a_irf,'-k','Linewidth',2)
title('a')

subplot(2,3,2)
plot(t,x_irf2,'k',t,zeros(T,1),'--b','Linewidth',2)
title('x')

subplot(2,3,3)
plot(t,pi_irf2,'k',t,zeros(T,1),'--b','Linewidth',2)
title('\pi')

subplot(2,3,4)
plot(t,i_irf2,'k',t,rf_irf2,'--b','Linewidth',2)
title('i')

subplot(2,3,5)
plot(t,y_irf2,'k',t,yf_irf2,'--b','Linewidth',2)
title('y')
legend('ZLB','No ZLB')
```