Table of Contents

Credit Modol with Firm Dynamics

```
clear all;
close all;
% Second version

Parallel=0 % 2 for GPU, 1 for parallel CPU, 0 for single CPU.

rng('default') % For reproducibility
tic;


Parallel =

    0
```

Toolkit options

```
tauchenoptions.parallel=Parallel;

mcmomentsoptions.T=10^4;
mcmomentsoptions.Tolerance=10^(-9);
mcmomentsoptions.parallel=tauchenoptions.parallel;

vfoptions.parallel=Parallel;

simoptions.burnin=10^4;
simoptions.simperiods=10^5; % if iterate=0 then simperiod=10^6
```

```
simoptions.iterate=1;
simoptions.parallel=Parallel;

simoptions.maxit=10^4;

heteroagentoptions.verbose=1;
```

Parameters Calibration

```
% Preferences
Params.beta=0.9;% Discount rate

% Firm-level technology
Params.alpha=0.3;  % Capital share
Params.gamma=0.5; % alpha + gamma must be ~= 1
Params.delta=0.05; % Depreciation rate of physical capital
Params.cf=1; % Fixed cost of production

% Entry and Exit
Params.ce=1; % Fixed cost of entry
Params.lambda=0.2; % Probability of firm exit
% lambda is the average observed exit percentage between 2007--2017
% (https://sidra.ibge.gov.br/Tabela/2718#resultado)
Params.oneminuslambda=1-Params.lambda; % Probability of survival

% Distortions
Params.taurate=0; % This is the rate for the tax.
Params.subsidyrate=0; % This is the rate for the subsidy.
Params.gcost=0.01; % capital adjustment cost parameter

% Initial guesses
Params.p=1; % output price
Params.Ne=0.5; % total mass of new entrants

% Declare discount factors
DiscountFactorParamNames={'beta','oneminuslambda'};
% Declare percentage of entrants
EntryExitParamNames.MassOfNewAgents={'Ne'};
% Exogenous survival probability
EntryExitParamNames.CondlProbOfSurvival={'oneminuslambda'};
```

Steady-state interest rate

```
Params.i=1/Params.beta-1; % gross capital return
Params.r=Params.i+Params.delta; % net capital return
```

Exogenous state variables

```
n_s= 20; % firm-specific Productivity level
n_psi = 5; % credit tax
```

```matlab
% Exogenous AR(1) process on (log) productivity
% logz=a+rho*log(z)+epsilon, epsilon~N(0,sigma_epsilon^2)
Params.rho=0.93;
Params.sigma_logz=sqrt(0.53);
Params.sigma_epsilon=sqrt((1-Params.rho)*((Params.sigma_logz)^2));
Params.a=0.098;

tauchenoptions.parallel=Parallel;
Params.q=2; % Hopenhayn & Rogerson (1993) do not report (based on
 Table 4 is seems something around q=4 is used, otherwise don't get
 values of z anywhere near as high as 27.3. (HR1993 have typo and call
 the column 'log(s)' when it should be 's')
[s_grid,
 pi_s]=TauchenMethod(Params.a,Params.sigma_epsilon^2,Params.rho,n_s,Params.q,tauch
 transmatrix]=TauchenMethod_Param(mew,sigmasq,rho,znum,q,Parallel,Verbose),
 transmatix is (z,zprime)
s_grid=exp(s_grid);

% Tax credit
psi_grid = linspace(-1,1,n_psi)';

% Transition matrix
% Note: considering that productivity and taxes are independent
n_z=[n_s,length(psi_grid)];
z_grid=[s_grid; psi_grid];


% transition matrix for the exogenous z and psi variables
pi_z=kron( pi_s,eye(prod(n_psi)))';

% Check transition matrix
for ii = 1: length(pi_z)
A = round(sum(pi_z(:,ii)),5);
if A == 1
else
    error('transition matrix sum is not one')
end
end
pi_z=pi_z';
```

Endogenous state variables

```matlab
% grid for capital
n_a=50;

% steady-state capital without distotions
%%%%% The grid is like the one in the Aiygari example
k_ss = (Params.alpha/Params.r)^(1-Params.gamma/1-Params.gamma-
Params.alpha)*...
    (Params.gamma)^(Params.gamma/1-Params.alpha-Params.gamma);
nk1 = floor(n_a/3); nk2=floor(n_a/3); nk3=n_a-nk1-nk2;
a_grid = sort([linspace(0,k_ss,nk1),linspace(k_ss
+0.0001,3*k_ss,nk2),...
```

```
            linspace(3*k_ss+0.0001,15*k_ss,nk3)])';
```

Decision varibles
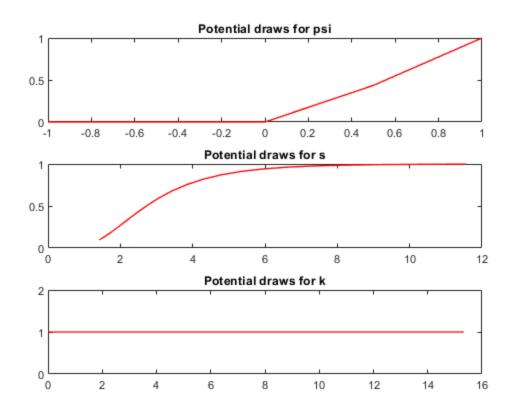
```
%There is no d variable

d_grid=[];
n_d=0;
```

Check endogenous, exogenous and decision variables

```
disp('sizes')
disp('vector(s) of endogenous state variables')
disp(n_a)
disp('vector(s) of exogenous state variable')
disp(n_z)
disp('vector(s) of decision variabes')
disp(n_d)

sizes
vector(s) of endogenous state variables
    50

vector(s) of exogenous state variable
    20     5

vector(s) of decision variabes
     0
```

Potential New Entrants Distribution over the states (s, psi, k)

```
% productivity (exogenous state)
cumsum_pistar_s = logncdf(s_grid,1,0.5)';
pistar_s=(cumsum_pistar_s-[0,cumsum_pistar_s(1:end-1)]);

% credit tax (exogenous state)
cumsum_pistar_psi = betacdf(psi_grid,.5,.4)';
pistar_psi =(cumsum_pistar_psi-[0,cumsum_pistar_psi(1:end-1)]);

% capital (endogenous state)
pistar_k = zeros(1,n_a);
pistar_k(1,1) = 1;
cumsum_pistar_k = cumsum(pistar_k);

if (abs(1-sum(pistar_psi)) || abs(sum(pistar_psi)-1)||
abs(sum(pistar_k)-1) > 1e-7)
    error('Draws are NOT a PMD.')
```

```
end

figure(1)
set(groot,'DefaultAxesColorOrder',[0 0 0],...

    'DefaultAxesLineStyleOrder','-|-|--|:','DefaultLineLineWidth',1);
subplot(3,1,1);
plot(psi_grid,cumsum_pistar_psi,'r')
title('Potential draws for psi')
subplot(3,1,2);
plot(s_grid,cumsum_pistar_s,'r')
title('Potential draws for s')
subplot(3,1,3);
plot(a_grid,cumsum_pistar_k,'r')
title('Potential draws for k')
```


Return Function
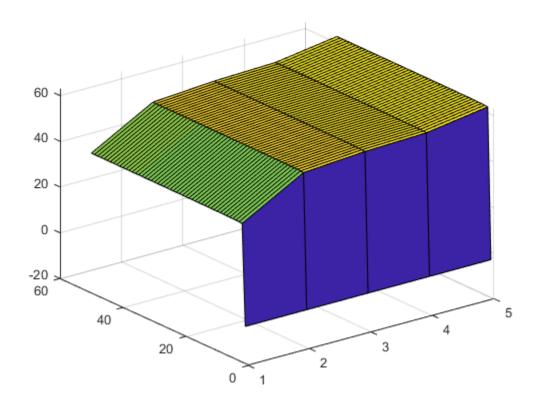
```
ReturnFn=@(aprime_val, a_val,s_val, tau_val, p,r,
 alpha,gamma,delta,taurate,subsidyrate, cf, gcost)...
RR2008p_ReturnFn(aprime_val, a_val,s_val, tau_val, p,r,
 alpha,gamma,delta,taurate,subsidyrate, cf, gcost);

ReturnFnParamNames={ 'p','r', 'alpha','gamma', 'delta','taurate','subsidyrate', 'c
```
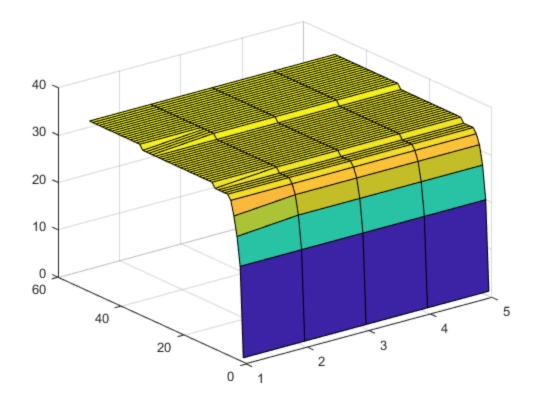
CHECK (to be erase)

```
if vfoptions.parallel==2
    V0=zeros([n_a,n_z,'gpuArray']);
else
    V0=zeros([n_a,n_z]);
end
[V,Policy]=ValueFnIter_Case1(V0, n_d,n_a,n_z,d_grid,...
    a_grid,z_grid, pi_z, ReturnFn, Params,
 DiscountFactorParamNames,...
    ReturnFnParamNames, vfoptions);

figure;
surf(squeeze(V(:,1,:)))

figure;
surf(squeeze(Policy(1,:,1,:)))
```
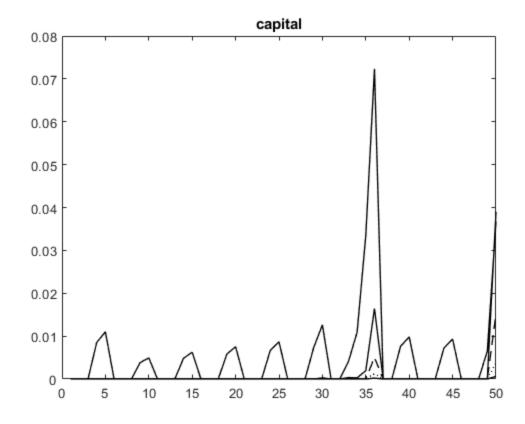
Aspects of the Endogenous entry

Exit is exogenous with probability lambda

```
simoptions.agententryandexit=1;
simoptions.endogenousexit=0;

% Probability of being in the (s, psi) category
EntryExitParamNames.DistOfNewAgents={'upsilon'};

pistar_psi_s=pistar_s.*(pistar_psi)';
Params.upsilon=NaN(n_psi,n_s,n_a);
 for n=1:n_a
    Params.upsilon(:,:,n)=pistar_psi_s.*pistar_k(n);
 end

disp('upsilon size')
disp(size(Params.upsilon))

disp('sum of upsilon')
disp(sum(Params.upsilon(:)))

upsilon size
     5    20    50

sum of upsilon
```

0.9981

CHECK (to be erased)

```
simoptions.parallel=Parallel

StationaryDist=StationaryDist_Case1(Policy,n_d,n_a,n_z,pi_z,...
    simoptions,Params,EntryExitParamNames);

figure;
surf(squeeze(StationaryDist.pdf(:,1,:)))


plot(squeeze(StationaryDist.pdf(:,1,:)))
title('capital')
```

simoptions =

struct with fields:

burnin: 10000
simperiods: 100000
iterate: 1
parallel: 0
maxit: 10000
agententryandexit: 1
endogenousexit: 0

Starting parallel pool (parpool) using the 'local' profile ...
connected to 4 workers.

capital

```
%Use the toolkit to find the equilibrium price index
GEPriceParamNames={'p'}%, 'Ne'};

%FnsToEvaluateParamNames(1).Names={};
%FnsToEvaluate={};

heteroagentoptions.specialgeneqmcondn={0,'entry'};

FnsToEvaluateParamNames(1).Names={'alpha','gamma','r','p','taurate'};
FnsToEvaluateFn_nbar
 =@(aprime_val,a_val,z1_val,z2_val,mass,alpha,gamma,r,p,taurate)...
(((1-taurate*z2_val)*p*z1_val*gamma))^(1/(1-gamma))
 *aprime_val^(alpha/(1-gamma));
FnsToEvaluate={FnsToEvaluateFn_nbar};


GEPriceParamNames =

  1×1 cell array

    {'p'}


AggVars=EvalFnOnAgentDist_AggVars_Case1(StationaryDist, Policy,...
    FnsToEvaluate, Params, FnsToEvaluateParamNames, n_d, n_a, n_z,...
    d_grid, a_grid, z_grid,
 simoptions.parallel,simoptions,EntryExitParamNames);
```

```
AggVars


AggVars =

   43.6629


GEPriceParamNames={'p', 'Ne'};
GeneralEqmEqnParamNames(1).Names={};
GeneralEqmEqn_LabourMarket = @(AggVars,GEprices) 1-AggVars;

GeneralEqmEqnParamNames(2).Names={'beta','ce'};
GeneralEqmEqn_Entry = @(EValueFn,GEprices,beta,ce) beta*EValueFn-ce; %
 Free entry conditions (expected returns equal zero in eqm); note that
 the first 'General eqm price' is ce, the fixed-cost of entry.

GeneralEqmEqns={GeneralEqmEqn_LabourMarket,GeneralEqmEqn_Entry};
```

Find equilibrium prices

```
heteroagentoptions.verbose=1;
n_p=0;
% uncomment after erase the 'to be erase' chunks
% initial value function
%if vfoptions.parallel==2
%    V0=zeros([n_a,n_z,'gpuArray']);
%else
%    V0=zeros([n_a,n_z]);
%end

disp('Calculating price vector corresponding to the stationary eqm')
[p_eqm,p_eqm_index,GeneralEqmCondn]=HeteroAgentStationaryEqm_Case1(V0,...
    n_d, n_a, n_z, n_p, pi_z, d_grid, a_grid, z_grid, ReturnFn,...
    FnsToEvaluate, GeneralEqmEqns, Params,
 DiscountFactorParamNames,...
    ReturnFnParamNames, FnsToEvaluateParamNames,
 GeneralEqmEqnParamNames,...
    GEPriceParamNames,heteroagentoptions, simoptions, vfoptions,
 EntryExitParamNames);

Calculating price vector corresponding to the stationary eqm
Current Aggregates:

AggVars =

   43.6629


Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    1.0000
    0.5000


GeneralEqmConditionsVec =

  -42.6629   38.6662

Current Aggregates:

AggVars =

   48.4420

Current GE prices and GeneralEqmConditionsVec:

p =

    1.0500
    0.5000


GeneralEqmConditionsVec =

  -47.4420   43.6075

Current Aggregates:

AggVars =

   45.8460

Current GE prices and GeneralEqmConditionsVec:

p =

    1.0000
    0.5250


GeneralEqmConditionsVec =

  -44.8460   38.6662

Current Aggregates:

AggVars =

   41.1073

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.9500
    0.5250


GeneralEqmConditionsVec =

  -40.1073   34.0029

Current Aggregates:

AggVars =

    37.5928

Current GE prices and GeneralEqmConditionsVec:

p =

    0.9000
    0.5375


GeneralEqmConditionsVec =

  -36.5928   29.6097

Current Aggregates:

AggVars =

    35.8443

Current GE prices and GeneralEqmConditionsVec:

p =

    0.9000
    0.5125


GeneralEqmConditionsVec =

  -34.8443   29.6097

Current Aggregates:

AggVars =

    31.4571

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
     0.8500
     0.5062


GeneralEqmConditionsVec =

  -30.4571   25.4791

Current Aggregates:

AggVars =

    26.1283

Current GE prices and GeneralEqmConditionsVec:

p =

     0.7500
     0.5437


GeneralEqmConditionsVec =

  -25.1283   17.9809

Current Aggregates:

AggVars =

    18.2275

Current GE prices and GeneralEqmConditionsVec:

p =

     0.6250
     0.5656


GeneralEqmConditionsVec =

  -17.2275   10.0897

Current Aggregates:

AggVars =

    14.3449

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.5750
    0.5344


GeneralEqmConditionsVec =

  -13.3449    7.4216

Current Aggregates:

AggVars =

    6.9685

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4125
    0.5328


GeneralEqmConditionsVec =

  -5.9685    0.4967

Current Aggregates:

AggVars =

    0.5136

Current GE prices and GeneralEqmConditionsVec:

p =

    0.1875
    0.5922


GeneralEqmConditionsVec =

    0.4864   -4.0734

Current Aggregates:

AggVars =

     0

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    -0.1438
     0.6352


GeneralEqmConditionsVec =

    1.0000   -4.2082

Current Aggregates:

AggVars =

     0

Current GE prices and GeneralEqmConditionsVec:

p =

   -0.0250
    0.5594


GeneralEqmConditionsVec =

    1.0000   -4.2082

Current Aggregates:

AggVars =

     0

Current GE prices and GeneralEqmConditionsVec:

p =

   -0.2500
    0.6187


GeneralEqmConditionsVec =

    1.0000   -4.2082

Current Aggregates:

AggVars =

     0

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    -0.0844
     0.5973


GeneralEqmConditionsVec =

    1.0000    -4.2082

Current Aggregates:

AggVars =

    1.9477

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2469
    0.5543


GeneralEqmConditionsVec =

   -0.9477    -3.5031

Current Aggregates:

AggVars =

    6.9685

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4125
    0.5328


GeneralEqmConditionsVec =

   -5.9685     0.4967

Current Aggregates:

AggVars =

    9.7831

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.4594
    0.5871


GeneralEqmConditionsVec =

  -8.7831    2.2310

Current Aggregates:

AggVars =

    0

Current GE prices and GeneralEqmConditionsVec:

p =

    0.0961
    0.5663


GeneralEqmConditionsVec =

   1.0000   -4.2082

Current Aggregates:

AggVars =

    1.1334

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2172
    0.5732


GeneralEqmConditionsVec =

  -0.1334   -3.8678

Current Aggregates:

AggVars =

    0

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.1109
    0.5568


GeneralEqmConditionsVec =

    1.0000   -4.2082

Current Aggregates:

AggVars =

    4.9421

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3531
    0.5707


GeneralEqmConditionsVec =

   -3.9421   -1.3014

Current Aggregates:

AggVars =

    3.0779

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2926
    0.5672


GeneralEqmConditionsVec =

   -2.0779   -2.6925

Current Aggregates:

AggVars =

    3.7565

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3223
    0.5483


GeneralEqmConditionsVec =

   -2.7565   -2.0597

Current Aggregates:

AggVars =

    5.4283

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3680
    0.5612


GeneralEqmConditionsVec =

   -4.4283   -0.8957

Current Aggregates:

AggVars =

    2.6597

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2771
    0.5560


GeneralEqmConditionsVec =

   -1.6597   -2.9883

Current Aggregates:

AggVars =

    2.0324

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.2475
    0.5750


GeneralEqmConditionsVec =

   -1.0324   -3.4942

Current Aggregates:

AggVars =

    3.2833

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3036
    0.5550


GeneralEqmConditionsVec =

   -2.2833   -2.4684

Current Aggregates:

AggVars =

    3.7743

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3190
    0.5662


GeneralEqmConditionsVec =

   -2.7743   -2.1338

Current Aggregates:

AggVars =

    2.9109

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.2876
    0.5586


GeneralEqmConditionsVec =

   -1.9109   -2.7901

Current Aggregates:

AggVars =

    3.1146

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2986
    0.5463


GeneralEqmConditionsVec =

   -2.1146   -2.5712

Current Aggregates:

AggVars =

    3.1258

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3016
    0.5358


GeneralEqmConditionsVec =

   -2.1258   -2.5092

Current Aggregates:

AggVars =

    3.5128

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3176
    0.5322


GeneralEqmConditionsVec =

   -2.5128   -2.1658

Current Aggregates:

AggVars =

    3.3359

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3156
    0.5131


GeneralEqmConditionsVec =

   -2.3359   -2.2094

Current Aggregates:

AggVars =

    3.3578

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3216
    0.4921


GeneralEqmConditionsVec =

   -2.3578   -2.0744

Current Aggregates:

AggVars =

    2.9801

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3057
    0.4957


GeneralEqmConditionsVec =

  -1.9801   -2.4243

Current Aggregates:

AggVars =

    2.7458

Current GE prices and GeneralEqmConditionsVec:

p =

    0.2997
    0.4775


GeneralEqmConditionsVec =

  -1.7458   -2.5482

Current Aggregates:

AggVars =

    2.9075

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3197
    0.4338


GeneralEqmConditionsVec =

  -1.9075   -2.1172

Current Aggregates:

AggVars =

    2.7526

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3288
    0.3828


GeneralEqmConditionsVec =

   -1.7526    -1.9084

Current Aggregates:

AggVars =

    2.2362

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3069
    0.3681


GeneralEqmConditionsVec =

   -1.2362    -2.3984

Current Aggregates:

AggVars =

    2.0833

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3360
    0.2734


GeneralEqmConditionsVec =

   -1.0833    -1.7368

Current Aggregates:

AggVars =

    1.4982

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3541
    0.1714


GeneralEqmConditionsVec =

   -0.4982   -1.2759

Current Aggregates:

AggVars =

    1.9060

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3760
    0.1860


GeneralEqmConditionsVec =

   -0.9060   -0.6644

Current Aggregates:

AggVars =

    1.2263

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4105
    0.0950


GeneralEqmConditionsVec =

   -0.2263    0.4300

Current Aggregates:

AggVars =

   -1.7359

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.4358
   -0.1164


GeneralEqmConditionsVec =

    2.7359    1.3307

Current Aggregates:

AggVars =

    2.2754

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3556
    0.2580


GeneralEqmConditionsVec =

   -1.2754   -1.2369

Current Aggregates:

AggVars =

    0.1074

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4091
    0.0084


GeneralEqmConditionsVec =

    0.8926    0.3804

Current Aggregates:

AggVars =

   -1.1650

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
   0.4655
  -0.0680


GeneralEqmConditionsVec =

   2.1650    2.4750

Current Aggregates:

AggVars =

   1.1927

Current GE prices and GeneralEqmConditionsVec:

p =

   0.3820
   0.1116


GeneralEqmConditionsVec =

  -0.1927   -0.4869

Current Aggregates:

AggVars =

   2.1407

Current GE prices and GeneralEqmConditionsVec:

p =

   0.3834
   0.1981


GeneralEqmConditionsVec =

  -1.1407   -0.4425

Current Aggregates:

AggVars =

   0.6851

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.4027
    0.0558


GeneralEqmConditionsVec =

    0.3149    0.1667

Current Aggregates:

AggVars =

    0.5720

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4313
    0.0393


GeneralEqmConditionsVec =

    0.4280    1.1618

Current Aggregates:

AggVars =

    1.0882

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3943
    0.0935


GeneralEqmConditionsVec =

   -0.0882   -0.1046

Current Aggregates:

AggVars =

    0.5988

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3864
    0.0543


GeneralEqmConditionsVec =

    0.4012    -0.3513

Current Aggregates:

AggVars =

    1.0526

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4045
    0.0848


GeneralEqmConditionsVec =

    -0.0526    0.2276

Current Aggregates:

AggVars =

    1.4393

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3961
    0.1225


GeneralEqmConditionsVec =

    -0.4393    -0.0457

Current Aggregates:

AggVars =

    0.8799

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
   0.4010
   0.0725


GeneralEqmConditionsVec =

   0.1201    0.1131

Current Aggregates:

AggVars =

   0.9214

Current GE prices and GeneralEqmConditionsVec:

p =

   0.3908
   0.0812


GeneralEqmConditionsVec =

   0.0786   -0.2145

Current Aggregates:

AggVars =

   0.9548

Current GE prices and GeneralEqmConditionsVec:

p =

   0.3942
   0.0821


GeneralEqmConditionsVec =

   0.0452   -0.1063

Current Aggregates:

AggVars =

   1.1430

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3875
    0.1031


GeneralEqmConditionsVec =

   -0.1430   -0.3181

Current Aggregates:

AggVars =

    0.9506

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0801


GeneralEqmConditionsVec =

    0.0494    0.0031

Current Aggregates:

AggVars =

    0.8150

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0687


GeneralEqmConditionsVec =

    0.1850    0.0014

Current Aggregates:

AggVars =

    1.0205

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3951
    0.0873


GeneralEqmConditionsVec =

  -0.0205   -0.0782

Current Aggregates:

AggVars =

    1.0188

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3985
    0.0854


GeneralEqmConditionsVec =

  -0.0188    0.0314

Current Aggregates:

AggVars =

    1.0540

Current GE prices and GeneralEqmConditionsVec:

p =

    0.4007
    0.0870


GeneralEqmConditionsVec =

  -0.0540    0.1013

Current Aggregates:

AggVars =

    0.9493

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.4011
    0.0782


GeneralEqmConditionsVec =

    0.0507    0.1140

Current Aggregates:

AggVars =

    1.0023

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3966
    0.0850


GeneralEqmConditionsVec =

   -0.0023   -0.0306

Current Aggregates:

AggVars =

    1.0692

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0902


GeneralEqmConditionsVec =

   -0.0692   -0.0024

Current Aggregates:

AggVars =

    0.9804

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3976
    0.0827


GeneralEqmConditionsVec =

    0.0196    0.0017

Current Aggregates:

AggVars =

    0.9652

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3957
    0.0823


GeneralEqmConditionsVec =

    0.0348   -0.0601

Current Aggregates:

AggVars =

    1.0044

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3978
    0.0846


GeneralEqmConditionsVec =

   -0.0044    0.0084

Current Aggregates:

AggVars =

    0.9841

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3988
    0.0822


GeneralEqmConditionsVec =

    0.0159    0.0409

Current Aggregates:

AggVars =

    0.9970

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3971
    0.0843


GeneralEqmConditionsVec =

    0.0030   -0.0128

Current Aggregates:

AggVars =

    1.0212

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3974
    0.0863


GeneralEqmConditionsVec =

   -0.0212   -0.0061

Current Aggregates:

AggVars =

    0.9907

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3975
    0.0836


GeneralEqmConditionsVec =

    0.0093   -0.0002

Current Aggregates:

AggVars =

    0.9988

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3982
    0.0838


GeneralEqmConditionsVec =

    0.0012    0.0210

Current Aggregates:

AggVars =

    0.9973

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3974
    0.0842


GeneralEqmConditionsVec =

    0.0027   -0.0043

Current Aggregates:

AggVars =

    0.9833

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3971
    0.0832


GeneralEqmConditionsVec =

    0.0167    -0.0130

Current Aggregates:

AggVars =

    0.9993

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0842


GeneralEqmConditionsVec =

    0.0007     0.0031

Current Aggregates:

AggVars =

    1.0062

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0849


GeneralEqmConditionsVec =

   -0.0062    -0.0010

Current Aggregates:

AggVars =

    1.0024

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3975
    0.0846


GeneralEqmConditionsVec =

  -0.0024   -0.0008

Current Aggregates:

AggVars =

   1.0040

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3977
    0.0846


GeneralEqmConditionsVec =

  -0.0040    0.0066

Current Aggregates:

AggVars =

   0.9993

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0843


GeneralEqmConditionsVec =

   0.0007   -0.0016

Current Aggregates:

AggVars =

   1.0020

Current GE prices and GeneralEqmConditionsVec:

p =
```

```
    0.3974
    0.0846


GeneralEqmConditionsVec =

   -0.0020   -0.0055

Current Aggregates:

AggVars =

    1.0001

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0843


GeneralEqmConditionsVec =

   1.0e-03 *

   -0.0511    0.9255

Current Aggregates:

AggVars =

    0.9969

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0841


GeneralEqmConditionsVec =

    0.0031    0.0001

Current Aggregates:

AggVars =

    1.0010

Current GE prices and GeneralEqmConditionsVec:
```

```
p =

    0.3975
    0.0844


GeneralEqmConditionsVec =

  -0.0010   -0.0006

Current Aggregates:

AggVars =

    1.0018

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0845


GeneralEqmConditionsVec =

  -0.0018    0.0019

Current Aggregates:

AggVars =

    0.9999

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0843


GeneralEqmConditionsVec =

  1.0e-03 *

   0.1073   -0.7231

Current Aggregates:

AggVars =

    0.9989
```

```
Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0842


GeneralEqmConditionsVec =

    0.0011    0.0008

Current Aggregates:

AggVars =

    1.0005

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0844


GeneralEqmConditionsVec =

    1.0e-03 *

    -0.4907   -0.2443

Current Aggregates:

AggVars =

    1.0003

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0844


GeneralEqmConditionsVec =

    -0.0003   -0.0019

Current Aggregates:

AggVars =
```

1.0001

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0844

GeneralEqmConditionsVec =

   *1.0e-03 ***

   -0.1214   0.2209

Current Aggregates:

AggVars =

    1.0007

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0844

GeneralEqmConditionsVec =

   *1.0e-03 ***

   -0.7196   0.6997

Current Aggregates:

AggVars =

    1.0001

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0844

GeneralEqmConditionsVec =

   *1.0e-03 ***

```
     -0.0994    -0.3674

Current Aggregates:

AggVars =

    0.9997

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0843


GeneralEqmConditionsVec =

   1.0e-03 *

    0.2699    0.0978

Current Aggregates:

AggVars =

    0.9998

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3976
    0.0843


GeneralEqmConditionsVec =

   1.0e-03 *

    0.2479    0.6861

Current Aggregates:

AggVars =

    1.0000

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0844
```

```
GeneralEqmConditionsVec =

   1.0e-03 *

   -0.0126   -0.1040

Current Aggregates:

AggVars =

    1.0004

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0844


GeneralEqmConditionsVec =

   1.0e-03 *

   -0.4039    0.0190

Current Aggregates:

AggVars =

    0.9999

Current GE prices and GeneralEqmConditionsVec:

p =

    0.3975
    0.0843


GeneralEqmConditionsVec =

   1.0e-03 *

    0.1015    0.0781

Current Aggregates:

AggVars =

    0.9998
```

Current GE prices and GeneralEqmConditionsVec:

p =

> *0.3975*
> *0.0843*

GeneralEqmConditionsVec =

> *1.0e-03 **

> *0.2103   -0.2468*

Current Aggregates:

AggVars =

> *1.0000*

Current GE prices and GeneralEqmConditionsVec:

p =

> *0.3975*
> *0.0844*

GeneralEqmConditionsVec =

> *1.0e-03 **

> *-0.0385   0.1040*

Value Function, Policy and Firm Distribution in GE

```
disp('Calculating various equilibrium objects')
Params.p=p_eqm.p;
Params.Ne=p_eqm.Ne;
[V,Policy]=ValueFnIter_Case1(V0, n_d,n_a,n_z,[],a_grid,z_grid,
 pi_z,...
    ReturnFn, Params, DiscountFactorParamNames,
 ReturnFnParamNames,vfoptions);

StationaryDist=StationaryDist_Case1(Policy,n_d,n_a,n_z,pi_z,...
    simoptions, Params, EntryExitParamNames);
```

Calculating various equilibrium objects

Post GE values

```matlab
FnsToEvaluateParamNames(1).Names={'alpha','gamma','r','p','taurate','subsidyrate'}
FnsToEvaluateFn_kbar =
 @(aprime_val,a_val,z1_val,z2_val,mass,alpha,gamma,r,p,...
    taurate,subsidyrate) aprime_val;
FnsToEvaluateParamNames(2).Names={'alpha','gamma','r','p','taurate','subsidyrate'}
FnsToEvaluateFn_output =
 @(aprime_val,a_val,z1_val,z2_val,mass,alpha,gamma,...
    r,p,taurate,subsidyrate)  p*((1-
taurate*z2_val)*z1_val)*(aprime_val^alpha)*...
    ((((((1-taurate*z2_val)*z1_val)*p*gamma))^(1/(1-gamma))
 *aprime_val^(alpha/(1-gamma)))^gamma);
FnsToEvaluateParamNames(3).Names={'alpha','gamma','r','p','taurate'};
FnsToEvaluateFn_nbar
 =@(aprime_val,a_val,z1_val,z2_val,mass,alpha,gamma,r,p,taurate)...
(((1-taurate*z2_val)*p*z1_val*gamma))^(1/(1-gamma))
 *aprime_val^(alpha/(1-gamma));
FnsToEvaluate={FnsToEvaluateFn_kbar,
 FnsToEvaluateFn_output,FnsToEvaluateFn_nbar};

%FnsToEvaluateParamNames(1).Names={'alpha','gamma',
 'delta','r','p','taurate','subsidyrate'};

%FnsToEvaluateParamNames(1).Names={};
% Capital
%FnsToEvaluateFn_capital =
 @(aprime_val,a_val,z1_val,z2_val,mass,alpha,gamma,r,p,taurate,subsidyrate)
 aprime_val;
%FnsToEvaluate={FnsToEvaluateFn_capital};

AggVars=EvalFnOnAgentDist_AggVars_Case1(StationaryDist, Policy,...
    FnsToEvaluate, Params, FnsToEvaluateParamNames, n_d, n_a, n_z,...
    d_grid, a_grid, z_grid,
 simoptions.parallel,simoptions,EntryExitParamNames);

ValuesOnGrid=EvalFnOnAgentDist_ValuesOnGrid_Case1_Mass(StationaryDist.pdf,...
    StationaryDist.mass, Policy, FnsToEvaluate, Params,...
    FnsToEvaluateParamNames,EntryExitParamNames, n_d, n_a, n_z,...
    [], a_grid, z_grid, Parallel,simoptions);


ProbDensityFns=EvalFnOnAgentDist_pdf_Case1(StationaryDist, Policy,
 FnsToEvaluate,...
    Params, FnsToEvaluateParamNames, n_d, n_a, n_z, d_grid, a_grid,
 z_grid,...
    simoptions.parallel,simoptions,EntryExitParamNames);
```

Agggregate Values

```matlab
Output.Y=AggVars(2);
Output.N=AggVars(3);
Output.K=AggVars(1);
```

```
Output.KdivY=Output.K/Output.Y;
```

Average values

```
Output.perY=AggVars(2)/StationaryDist.mass;
Output.perN=AggVars(3)/StationaryDist.mass;
Output.perK=AggVars(1)/StationaryDist.mass;

Output.TFP=(Output.Y/Output.N)./((Output.K/Output.N)^Params.alpha);


%%%%%%%%%%%%%%
nbarValues=shiftdim(ValuesOnGrid(3,:,:,:),1);
normalize_employment=min(min(min(shiftdim(ValuesOnGrid(3,2:end,:,:),1)))); %
 Normalize so that smallest occouring value of nbar in the baseline is
 equal to 1.
nbarValues=nbarValues./normalize_employment;


Partion1Indicator=logical(nbarValues<5);
Partion2Indicator=logical((nbarValues>=5).*(nbarValues<50));
Partion3Indicator=logical(nbarValues>=50);

if ((sum(sum(sum(Partion1Indicator+Partion2Indicator
+Partion3Indicator)))) - prod(n_z)*(n_a) > 1e-3)
    error('error')
end

ShareOfEstablishments(1)=sum(sum(sum(StationaryDist.pdf(Partion1Indicator))));
ShareOfEstablishments(2)=sum(sum(sum(StationaryDist.pdf(Partion2Indicator))));
ShareOfEstablishments(3)=sum(sum(sum(StationaryDist.pdf(Partion3Indicator))));
ShareOfEstablishments(4)=sum(sum(sum(StationaryDist.pdf)));

Output_pdf=shiftdim(ProbDensityFns(2,:,:,:),1);
ShareOfOutput(1)=sum(sum(sum(Output_pdf(Partion1Indicator))));
ShareOfOutput(2)=sum(sum(sum(Output_pdf(Partion2Indicator))));
ShareOfOutput(3)=sum(sum(sum(Output_pdf(Partion3Indicator))));
ShareOfOutput(4)=sum(sum(sum(Output_pdf)));

Labour_pdf=shiftdim(ProbDensityFns(3,:,:,:),1);
ShareOfLabour(1)=sum(sum(sum(Labour_pdf(Partion1Indicator))));
ShareOfLabour(2)=sum(sum(sum(Labour_pdf(Partion2Indicator))));
ShareOfLabour(3)=sum(sum(sum(Labour_pdf(Partion3Indicator))));
ShareOfLabour(4)=sum(sum(sum(Labour_pdf)));

Capital_pdf=shiftdim(ProbDensityFns(1,:,:,:),1);
ShareOfCapital(1)=sum(sum(sum(Capital_pdf(Partion1Indicator))));
ShareOfCapital(2)=sum(sum(sum(Capital_pdf(Partion2Indicator))));
ShareOfCapital(3)=sum(sum(sum(Capital_pdf(Partion3Indicator))));
ShareOfCapital(4)=sum(sum(sum(Capital_pdf)));

AverageEmployment(1)=sum(sum(sum(nbarValues(Partion1Indicator).*...
StationaryDist.pdf(Partion1Indicator))))/sum(sum(sum(nbarValues.*...
```

```
StationaryDist.pdf)));
AverageEmployment(2)=sum(sum(sum(nbarValues(Partion2Indicator).*...
StationaryDist.pdf(Partion2Indicator)))))/sum(sum(sum(nbarValues.*...
StationaryDist.pdf)));
AverageEmployment(3)=sum(sum(sum(nbarValues(Partion3Indicator).*...
StationaryDist.pdf(Partion3Indicator)))))/sum(sum(sum(nbarValues.*...
StationaryDist.pdf)));
AverageEmployment(4)=sum(sum(sum(nbarValues.*...
StationaryDist.pdf)))/sum(sum(sum(nbarValues.*...
StationaryDist.pdf)));

fprintf('Distribution statistics of benchmark economy  \n');
fprintf('                              <5      5 to 49     >=50
 total\n');
fprintf('Share of establishments  %8.2f  %8.2f  %8.2f  %8.2f  \n',
 ShareOfEstablishments);
fprintf('Share of output          %8.2f  %8.2f  %8.2f  %8.2f\n',
 ShareOfOutput);
fprintf('Share of labour          %8.2f  %8.2f  %8.2f  %8.2f\n',
 ShareOfLabour);
fprintf('Share of capital         %8.2f  %8.2f  %8.2f  %8.2f\n',
 ShareOfCapital);
fprintf('Share of employment      %8.2f  %8.2f  %8.2f  %8.2f\n',
 AverageEmployment);
```

Distribution statistics of benchmark economy

	<5	*5 to 49*	*>=50*	*total*
Share of establishments	*0.49*	*0.19*	*0.32*	*1.00*
Share of output	*0.01*	*0.02*	*0.96*	*1.00*
Share of labour	*0.01*	*0.02*	*0.96*	*1.00*
Share of capital	*0.06*	*0.05*	*0.89*	*1.00*
Share of employment	*0.01*	*0.02*	*0.96*	*1.00*

Display some output about the solution

```
fprintf('The equilibrium output price is p=%.4f \n', Params.p)
fprintf('The equilibrium value for the mass of entrants is Ne=%.4f
 \n', Params.Ne)

fprintf('Average Labor is n=%.4f \n', Output.perN)
fprintf('Average Capital is k=%.4f \n', Output.perK)
fprintf('Average Output is y=%.4f \n', Output.perY)
fprintf('Total Factor Productivity is TFP=%.4f \n', Output.TFP)


toc;
```

The equilibrium output price is p=0.3975
The equilibrium value for the mass of entrants is Ne=0.0844
Average Labor is n=2.3756
Average Capital is k=4.7089
Average Output is y=4.7511
Total Factor Productivity is TFP=1.6289
Elapsed time is 528.675358 seconds.

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