

APÊNDICE B – CÓDIGO COMPUTACIONAL PARA A RESOLUÇÃO DO MODELO EM DYNARE

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% Code for Master Thesis
% Alexandre Carvalho da Cruz
% This version: February 2015

% Based on Gerali et. al. (2010)

% Comments:

% RBC (medium scale DSGE) model with: investment adjustment costs,
variable
% capital utilization, sticky bank rates (banks in monopolistic
competition)

% 10 sections in the model block: 1) Households, 2) Entrepreneurs, 3)
Capital
% Producers, 4) Retailers, 5) Banks, 6) Monetary Policy, 7)
Aggregation,
% 8) Market Clearing, 9) Variable of Interest, 10) Exogenous Processes

var
  c_H          % 1 Households consumption
  h_H          % 2 Households labor
  d_H          % 3 Households deposits
  w_H          % 4 Households wage
  lambda_H    % 5 Households budget constraint multiplier
  SDF_H        % 6 Households Stochastic Discount Factor

  c_E          % 7 Entrepreneurs consumption
  h_EE        % 8 Entrepreneurs labor
  h_EH        % 9 Entrepreneurs household labor demand
  b_E          % 10 Entrepreneurs loans
  k_E          % 11 Entrepreneurs capital utilization
  u           % 12 Entrepreneurs capital utilization rate
  y_E          % 13 Entrepreneurs wholesale good production
  lambda_E    % 14 Entrepreneurs budget constraint multiplier
  s_E          % 15 Entrepreneurs incentive compatibility constraint
multiplier
  r_k          % 16 Capital rental rate
  SDF_E        % 17 Entrepreneurs Stochastic Discount Factor

  q_k          % 18 Price of capital in terms of final good price =
Entrepreneurs capital flow multiplier
  k_C          % 19 Capital Producers capital
  i_C          % 20 Capital Producers investment

  pi           % 21 Retailers inflation
  x           % 22 Retailers price of wholesale good in terms of
final good price
  y_R          % 23 Retailers output
  profit_R    % 24 Retailers profits

  k_B          % 25 Banks capital
  b_B          % 26 Banks loans
  d_B          % 27 Banks deposits
  R_b          % 28 Banks wholesale loans rate
  r_d          % 29 Banks retail deposits rate
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r_b          % 30 Banks retail loans rate
profit_B    % 31 Banks profits

R_i         % 32 Monetary Authority base interest rate

C_H         % 33 Aggregation Households
H_H         % 34 Aggregation Households
D_H         % 35 Aggregation Households

C_E         % 36 Aggregation Entrepreneurs
H_EE        % 37 Aggregation Entrepreneurs
H_EH        % 38 Aggregation Entrepreneurs
B_E         % 39 Aggregation Entrepreneurs
K_E         % 40 Aggregation Entrepreneurs
U           % 41 Aggregation Entrepreneurs
Y_E         % 42 Aggregation Entrepreneurs

K_C         % 43 Aggregation Capital Producers
I_C         % 44 Aggregation Capital Producers

Y_R         % 45 Aggregation Retailers

K_B         % 46 Aggregation Banks
B_B         % 47 Aggregation Banks
D_B         % 48 Aggregation Banks

C           % 49 Market Clearing
H           % 50 Market Clearing
D           % 51 Market Clearing
B           % 52 Market Clearing
K           % 53 Market Clearing
Y           % 54 Market Clearing
I           % 55 Market Clearing

spread      % 56 Average Bank Spread

a_E         % 57 Exogenous Process: Productivity
m_E         % 58 Exogenous Process: Entrepreneurs loan-to-value
ratio
epsilon_y   % 59 Exogenous Process: Elasticity of substitution of
final good
nu          % 60 Exogenous Process: Banks capital requirement
div        % 61 Exogenous Process: Households dividends
;

varexo
e_a_E      % 1 Productivity shock
e_m_E      % 2 Entrepreneurs loan-to-value ratio shock
e_epsilon_y % 3 Elasticity of substitution of final good
shock
e_nu       % 4 Banks capital requirement shock
e_div      % 5 Households dividends shock
e_R_i      % 6 Monetary policy conduction shock
;

parameters
A_H, beta_H % Households
A_E, beta_E, alpha, mu, etal, eta2 % Entrepreneurs
delta_k % Entrepreneurs and Capital Good Producers

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kappa_i % Capital Good Producers
kappa_p % Retailers
delta_kb, kappa_kb % Wholesale Banks
kappa_d, epsilon_d % Retail Banks - Deposits
kappa_b, epsilon_b % Retail Banks - Loans
rho_i, phi_pi, phi_y % Monetary Authority
rho_a_E, rho_m_E, rho_epsilon_y, rho_nu, rho_div %
Persistences of exogenous processes
pi_ss, R_i_ss, a_E_ss, m_E_ss, epsilon_y_ss, nu_ss, div_ss
% Steady state values
;

A_H = 1.4; % Calibrated
A_E = 0.6; % Calibrated

beta_H = 0.9943; % Gerali et al. (2010) - EU
beta_E = 0.975; % Gerali et al. (2010) - EU

alpha = 0.25; % Capital share in the production function / ( 1 - alpha
) = Labor share in the production function
% Gollin (2002) USA

mu = 0.9; % Households labor share in the production function / ( 1 -
mu ) = Entrepreneurs labor share in the production function
% Gollin (2002) USA

etal = 0.0469; % 1st capital utilization cost parameter according to
Schmitt-Grohé and Uribe (2006) specification
% Lima (2014) BRAZIL / Gerali et al. (2010) EU
eta2 = 0.1 * etal; % 2nd capital utilization cost parameter according
to Schmitt-Grohé and Uribe (2006) specification

delta_k = 0.025; % Depreciation rate of physical capital
% Gerali et al. (2010)

kappa_i = 10.0305562248008; % Adjustment cost to investment parameter
estimated by Gerali et al. (2010) EU
kappa_p = 33.7705265016395; % Adjustment cost to set prices parameter
estimated by Gerali et al. (2010) EU
kappa_kb = 8.91481958034669; % Adjustment cost to bank capital
parameter estimated by Gerali et al. (2010) EU
kappa_d = 2.77537377104213; % Adjustment cost to set deposit rates
parameter estimated by Gerali et al. (2010) EU
kappa_b = 7.98005959044637; % Adjustment cost to set loan rates
parameter estimated by Gerali et al. (2010) EU

delta_kb = 0.1; % Depreciation of bank capital (Bank capital managing
cost)
% Lima (2014) Brazil

%%%
epsilon_d = -1.46025; % Elasticity of substitution of deposits
epsilon_b = 2.932806; % Elasticity of substitution of loans
%%%

rho_i = 0.750481873084311; % Share of past nominal interest rate on
current nominal interest rate / ( 1 - rho_i ) = Share of steady state
nominal interest rate on current nominal interest rate - Gerali et al.
(2010) EU

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phi_pi = 2.00384780180824; % Share of current inflation deviation from
steady state on current nominal interest rate - Gerali et al. (2010)
EU
phi_y = 0.303247771697294; % Share of current output deviation from
steady state on current nominal interest rate - Gerali et al. (2010)
EU

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rho_a_E = 0.9;
rho_m_E = 0.9;
rho_epsilon_y = 0.9;
rho_nu = 0.9;
rho_div = 0.9;

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pi_ss = 1; % Steady state gross inflation rate
R_i_ss = ( pi_ss / beta_H - 1 ) * ( epsilon_d - 1 ) / epsilon_d; %
Steady state gross nominal interest rate
a_E_ss = exp(0);
m_E_ss = 0.35; % Entrepreneurs loan-to-value ratio at steady state
epsilon_y_ss = 6;
nu_ss = 0.09; % Banking Capital ratio over Loans (Basel II)
div_ss = 0.5;

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model;

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 1) Households %
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exp(c_H) + exp(d_H)
= exp(w_H) * exp(h_H) + ( 1 + exp(r_d(-1)) ) / exp(pi) * exp(d_H(-1))
+ exp(profit_R) + exp(div) * exp(profit_B);

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1 / exp(c_H) = exp(lambda_H);

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exp(lambda_H) * exp(w_H) = A_H * ( 1 / ( 1 - exp(h_H) ) );

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beta_H * exp(lambda_H(+1)) * ( 1 + exp(r_d) ) / exp(pi(+1)) =
exp(lambda_H);

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exp(SDF_H) = beta_H * exp(lambda_H) / exp(lambda_H(-1));

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% 2) Entrepreneurs %
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exp(c_E) + exp(w_H) * exp(h_EH) + ( 1 + exp(r_b(-1)) ) / exp(pi) *
exp(b_E(-1)) + exp(q_k) * ( exp(k_E) - (1 - delta_k) * exp(k_E(-1)) )
+ ( eta1 * ( exp(u) - 1 ) + eta2 / 2 * ( exp(u) - 1 )^2 ) * exp(k_E(-
1))
= exp(y_E) / exp(x) + exp(b_E);

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exp(y_E) = exp(a_E) * ( exp(k_E(-1)) * exp(u) )^alpha * exp(h_EH)^( mu
* ( 1 - alpha ) ) * exp(h_EE)^( ( 1 - mu ) * ( 1 - alpha ) );

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( 1 + exp(r_b) ) * exp(b_E)
= exp(m_E) * exp(q_k(+1)) * exp(pi(+1)) * ( 1 - delta_k ) * exp(k_E);

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1 / exp(c_E) = exp(lambda_E);

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$$\exp(\lambda_E) * (1 / \exp(x)) * \exp(y_E) * (1 - \mu) * (1 - \alpha) * \exp(h_{EE})^{(-1)} = A_E * (1 / (1 - \exp(h_{EE})));$$

$$(1 / \exp(x)) * \exp(y_E) * \mu * (1 - \alpha) * \exp(h_{EH})^{(-1)} = \exp(w_H);$$

$$\exp(\lambda_E) = \exp(s_E) * (1 + \exp(r_b)) + \beta_E * \exp(\lambda_{E(+1)}) * (1 + \exp(r_b)) / \exp(\pi(+1));$$

$$\begin{aligned} & \beta_E * \exp(\lambda_{E(+1)}) * (\exp(r_{k(+1)}) * \exp(u(+1)) + \exp(q_{k(+1)}) * (1 - \delta_k) - (\eta_1 * (\exp(u(+1)) - 1) + \eta_2 / 2 * ((\exp(u(+1)) - 1)^2))) \\ & + \exp(s_E) * \exp(m_E) * \exp(q_{k(+1)}) * \exp(\pi(+1)) * (1 - \delta_k) \\ & = \exp(\lambda_E) * \exp(q_k); \end{aligned}$$

$$\exp(r_k) = \eta_1 + \eta_2 * (\exp(u) - 1);$$

$$\exp(SDF_E) = \beta_E * \exp(\lambda_E) / \exp(\lambda_{E(-1)});$$

$$\begin{aligned} & (1 / \exp(x)) * (\exp(a_E) * \alpha * (\exp(k_{E(-1)}) * \exp(u))^{(\alpha - 1)} * \exp(h_{EH})^{(\mu * (1 - \alpha))} * \exp(h_{EE})^{((1 - \mu) * (1 - \alpha))}) \\ & = \exp(r_k); \end{aligned}$$

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 % 3) Capital Goods Producers (owned by entrepreneurs) %
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

$$\exp(k_C) = (1 - \delta_k) * \exp(k_{C(-1)}) + (1 - \kappa_i / 2 * (\exp(i_C) / \exp(i_{C(-1)}) - 1)^2) * \exp(i_C);$$

$$\begin{aligned} & \exp(q_k) * (1 - (\kappa_i / 2 * (\exp(i_C) / \exp(i_{C(-1)}) - 1)^2 + \kappa_i * \exp(i_C) / \exp(i_{C(-1)}) * (\exp(i_C) / \exp(i_{C(-1)}) - 1))) \\ & + \exp(SDF_E) * \exp(q_{k(+1)}) * \kappa_i * (\exp(i_{C(+1)}) / \exp(i_C))^{2 * (\exp(i_{C(+1)}) / \exp(i_C) - 1)} = 1; \end{aligned}$$

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 % 4) Retailers / Final Goods Producers (owned by households) %
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

$$\begin{aligned} & 1 - \exp(\epsilon_y) + \exp(\epsilon_y) / \exp(x) - \kappa_p * (\exp(\pi) - 1) * \exp(\pi) \\ & + \exp(SDF_H) * \kappa_p * (\exp(\pi(+1)) - 1) * \exp(\pi(+1))^2 * (\exp(y_{R(+1)}) / \exp(y_R)) = 0; \end{aligned}$$

$$\exp(\text{profit}_R) = \exp(y_R) * (1 - (1 / \exp(x)) - (\kappa_p / 2) * (\exp(\pi) - 1)^2);$$

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 % 5) Banks (owned by households) %
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 % 5.1) Wholesale Banks %
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

$$\exp(\pi) * \exp(k_B) = (1 - \delta_{kb}) * \exp(k_{B(-1)}) + (1 - \exp(\text{div})) * \exp(\text{profit}_B(-1)); \quad \% \text{ (XXI) Bank capital accumulation}$$

$$\exp(b_B) = \exp(d_B) + \exp(k_B);$$

$$\exp(R_b) - \exp(R_i) = -\kappa_{kb} * (\exp(k_B) / \exp(B) - \exp(\nu)) * (\exp(k_B) / \exp(B))^2;$$

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 5.2) Retail Banks - Deposits %
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$$-\epsilon_d * (\exp(R_i) / \exp(r_d)) - 1 + \epsilon_d - \kappa_d * (\exp(r_d) / \exp(r_{d(-1)}) - 1) * \exp(r_d) / \exp(r_{d(-1)}) + \exp(SDF_H) * \kappa_d * (\exp(r_{d(+1)}) / \exp(r_d) - 1) * (\exp(r_{d(+1)}) / \exp(r_d))^2 * \exp(d_B(+1)) / \exp(d_B) = 0;$$

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 5.3) Retail Banks - Loans %
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$$1 - \epsilon_b + \epsilon_b * (\exp(R_b) / \exp(r_b)) - \kappa_b * (\exp(r_b) / \exp(r_{b(-1)}) - 1) * \exp(r_b) / \exp(r_{b(-1)}) + \exp(SDF_H) * \kappa_b * (\exp(r_{b(+1)}) / \exp(r_b) - 1) * (\exp(r_{b(+1)}) / \exp(r_b))^2 * \exp(b_B(+1)) / \exp(b_B) = 0;$$

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 5.4) Banks Profits %
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$$-\kappa_{kb} / 2 * ((\exp(k_B) / \exp(B) - \exp(\nu))^2) * \exp(k_B) - \exp(r_d) * \exp(d_B) - \kappa_d / 2 * ((\exp(r_d) / \exp(r_{d(-1)}) - 1)^2) * \exp(r_d) * \exp(d_B) + \exp(r_b) * \exp(b_B) - \kappa_b / 2 * ((\exp(r_b) / \exp(r_{b(-1)}) - 1)^2) * \exp(r_b) * \exp(b_B) = \exp(\text{profit}_B);$$

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 6) Monetary Policy (Modified Taylor Rule) %
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$$(1 + \exp(R_i)) = (1 + R_{i,ss})^{(1 - \rho_i)} * (1 + \exp(R_i(-1)))^{\rho_i} * (\exp(\pi) / \pi_{ss})^{(\phi_\pi * (1 - \rho_i))} * (\exp(Y) / \exp(Y(-1)))^{(\phi_Y * (1 - \rho_i))} * (1 + e_{R_i});$$

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 7) Aggregating over symmetric Households, Entrepreneurs, Capital
Good Producers, Retailers, and Banks %
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```

$$\exp(C_H) = \exp(c_H);$$

$$\exp(H_H) = \exp(h_H);$$

$$\exp(D_H) = \exp(d_H);$$

$$\exp(C_E) = \exp(c_E);$$

$$\exp(H_{EE}) = \exp(h_{EE});$$

$$\exp(H_{EH}) = \exp(h_{EH});$$

$$\exp(B_E) = \exp(b_E);$$

$$\exp(K_E) = \exp(k_E);$$

$$\exp(U) = \exp(u);$$

$$\exp(Y_E) = \exp(y_E);$$

```
exp(K_C) = exp(k_C);
exp(I_C) = exp(i_C);
```

```
exp(Y_R) = exp(y_R);
```

```
exp(K_B) = exp(k_B);
exp(B_B) = exp(b_B);
exp(D_B) = exp(d_B);
```

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 8) Market Clearing %
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```
exp(C) = exp(c_H) + exp(c_E);
```

```
exp(H_H) = exp(H_EH);
exp(H) = exp(H_EH)^mu * exp(H_EE)^(1 - mu);
```

```
exp(D_H) = exp(D_B);
exp(D) = exp(D_B);
```

```
exp(B_E) = exp(B_B);
exp(B) = exp(B_B);
```

```
exp(K_E) = exp(K_C);
exp(K) = exp(K_C);
```

```
exp(Y_E) = exp(Y_R);
exp(Y) = exp(Y_R);
```

```
exp(I) = exp(I_C);
```

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 9) Variable of Interest: Spread %
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exp(spread) = exp(r_b) - exp(r_d);
```

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 10) Exogenous Processes %
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```
exp(a_E) = (1 - rho_a_E) * a_E_ss + rho_a_E * exp(a_E(-1)) + e_a_E;
```

```
exp(m_E) = (1 - rho_m_E) * m_E_ss + rho_m_E * exp(m_E(-1)) + e_m_E;
```

```
exp(epsilon_y) = (1 - rho_epsilon_y) * epsilon_y_ss + rho_epsilon_y * exp(epsilon_y(-1)) + e_epsilon_y;
```

```
exp(nu) = (1 - rho_nu) * nu_ss + rho_nu * exp(nu(-1)) + e_nu;
```

```
exp(div) = (1 - rho_div) * div_ss + rho_div * exp(div(-1)) + e_div;
```

```
end;
```

```
initval;
c_H = -0.8468;
```

```
h_H = -1.0478;
d_H = -0.9158;
w_H = -0.0784;
lambda_H = 0.8468;
SDF_H = -0.0111;
c_E = -2.6255;
h_EE = -0.7911;
h_EH = -1.0478;
b_E = -0.8203;
k_E = 0.2725;
u = 0.5903;
y_E = -0.5509;
lambda_E = 2.6255;
s_E = -1.7597;
r_k = -2.9823;
SDF_E = -0.0408;
q_k = -1.8388e-17;
k_C = 0.2725;
i_C = -3.9272;
pi = -1.2222e-16;
x = 0.1823;
y_R = -0.5509;
profit_R = -2.3426;
k_B = -3.2167;
b_B = -0.8203;
d_B = -0.9158;
R_b = -3.9812;
r_d = -4.4988;
r_b = -3.5642;
profit_B = -4.8262;
R_i = -3.9771;
spread = -4.0629;
end;
```

```
shocks;
```

```
var e_a_E = 0.05;
var e_m_E = 0.05;
var e_epsilon_y = 0.05;
var e_nu = 0.05;
var e_div = 0.05;
var e_R_i = 0.05;
end;
```

```
steady;
check;
```

```
stoch_simul(order = 1, irf = 60);
```