INSTITUTE FOR CAPACITY DEVELOPMENT

Workshop 6: Capital Flows and Policy Responses

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Daniel Baksa

Course on Monetary and Fiscal Policy Analysis with DSGE Models (OT26.08)

Workshop

1. Open economy model with flexible exchange rate and financial accelerator
   - Base model with financial accelerator
   - Model without financial accelerator
   - Model with financial accelerator and entrepreneurs' debt dollarization problems
2. Policy Responses to Capital Outflows
   a. Comparison: base, w/o accelerator and dollarization case
   b. Comparison: base vs limited flexibility of the ER (*managed float*)
   c. With dollarization: comparison ER flexibility vs managed float
   d. Base model with Macroprudential policy
   e. Macroprudential policy with dollarization

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   a. Comparison: base, w/o accelerator and dollarization case
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   e. Macroprudential policy with dollarization

Base model (I)

- BGG4.1:

$$\frac{Y_H}{Y} y_{H,t} = \left((1-\alpha_C)(\frac{C}{Y} + \frac{C^e}{Y}) + (1-\alpha_I)\frac{I}{Y} \right) d_{H,t} + \frac{G}{Y} g_t + \frac{C_H^*}{Y} c_{H,t}^*$$

- BGG4.2:

$$\left((1-\alpha_C)(\frac{C}{Y} + \frac{C^e}{Y}) + (1-\alpha_I)\frac{I}{Y} \right) d_{H,t} = (1-\alpha_C)\frac{C}{Y} c_t + (1-\alpha_C)\frac{C^e}{Y} c_t^e - (1-\alpha_C)(\frac{C}{Y} + \frac{C^e}{Y})\eta_C (p_{H,t} - p_t)$$

$$+ (1-\alpha_I)\frac{I}{Y}\Big(inv_t - \eta_I (p_{I,t} - p_t) \Big)$$

- BGG4.3:

$$c_{H,t}^* = y_t^* - \eta^* (p_{H,t} - p_t - rer_t)$$

Base model (II)

- BGG4.4: $$\frac{M}{Y}m_t = \alpha_C \frac{C}{Y}c_t + \alpha_C \frac{C^e}{Y}c^e_t - \alpha_C\left(\frac{C}{Y} + \frac{C^e}{Y}\right)\eta_C(p_{F,t} - p_t)$$
$$+\alpha_I \frac{I}{Y}\left(inv_t - \eta_I(p_{F,t} - p_{I,t})\right)$$
- BGG4.5:
$$\frac{X}{Y}x_t = \frac{C^*_H}{Y}c^*_{H,t} + \frac{Y_{CO}}{Y}y_{CO,t}$$
- BGG4.6:
$$\frac{X}{Y}(p_{X,t} - p_t) = \frac{C^*_H}{Y}(p_{H,t} - p_t) + \frac{Y_{CO}}{Y}(p^*_{CO,t} - p^*_t + rer_t)$$

Base model (III)

- BGG4.7: $$rer_t = rer_{t-1} + \Delta e_t + \pi_t^* - \pi_t$$
- BGG4.8: $$(p_{H,t} - p_t) = (p_{H,t-1} - p_{t-1}) + \pi_{H,t} - \pi_t$$
- BGG4.9: $$i_t = i_t^* + E_t\left[\Delta e_{t+1}\right] + \zeta b_t^*$$
- BGG4.10:

$$\frac{B^*}{Y}\left(rer_t + b_t^*\right) = \frac{B^*}{Y}\left(i_{t-1}^* + (1+\zeta)b_{t-1}^* + rer_t - \pi_t^*\right) + \frac{M}{Y}\left(rer_t + m_t\right)$$
$$+ \chi\frac{Y_{CO}}{Y}\left(p_{CO,t}^* - p_t^* + rer_t + y_{CO,t}\right) - \frac{X}{Y}\left(p_{X,t} - p_t + x_t\right)$$

Base model (IV)

- BGG4.11:

$$\pi_{F,t} = \frac{\beta}{1+\beta\chi_F} E_t\left[\pi_{F,t+1}\right] + \frac{\chi_F}{1+\beta\chi_F}\pi_{F,t-1} + \frac{(1-\theta_F)(1-\beta\theta_F)}{\theta_F(1+\beta\chi_F)}\left(rer_t - (p_{F,t} - p_t)\right)$$

- BGG4.12: $(p_{F,t} - p_t) = (p_{F,t-1} - p_{t-1}) + \pi_{F,t} - \pi_t$

- BGG4.13: $(p_{I,t} - p_t) = (1-\alpha_I)(p_{H,t} - p_t) + \alpha_I(p_{F,t} - p_t)$

- BGG4.14: $0 = (1-\alpha_C)(p_{H,t} - p_t) + \alpha_C(p_{F,t} - p_t)$

Base model (V)

- BGG4.15: $y_t = \frac{Y_H}{Y} y_{H,t} + \frac{Y_{CO}}{Y} y_{CO,t}$, notar que $\frac{Y_H}{Y} + \frac{Y_{CO}}{Y} = 1$

- BGG4.16: $c_t = -\sigma \frac{(1-h)}{1+h}\left(i_t - E_t \pi_{t+1}\right) + \frac{1}{1+h} E_t c_{t+1} + \frac{h}{1+h} c_{t-1}$

- BGG4.17: $c_t^e = n_t$

- BGG4.18: $E_t\left[rr_{t+1}^K + \pi_{t+1} - i_t \right] = sp_t$

Base model (VI)

- BGG4.19: $sp_t = \nu\left(q_t + k_t - n_t\right)$

- BGG4.20: $rr^k_t = \left(1-\varepsilon\right)(mc_t + y_t - k_{t-1}) + \varepsilon q_t - q_{t-1},$

  $\varepsilon = \dfrac{(1-\delta)}{R^K}$

- BGG4.21: $q_t - (p_{I,t} - p_t) = \zeta_{INV}\left(inv_t - inv_{t-1}\right) - \beta\zeta_{INV} E_t\left[inv_{t+1} - inv_t\right]$

- BGG4.22: $y_{H,t} = a_t + \alpha k_{t-1} + (1-\alpha) l_t$

Base model (VII)

- BGG4.23: $mrs_t = \sigma_L l_t + \frac{1}{\sigma}\frac{1}{(1-h)}c_t - \frac{1}{\sigma}\frac{h}{(1-h)}c_{t-1}$

- BGG4.24: $rw_t = mc_t + y_t - l_t$

- BGG4.25:

$$\pi_{H,t} = \frac{\beta}{1+\beta\chi_H}E_t\left[\pi_{H,t+1}\right] + \frac{\beta}{1+\beta\chi_H}\pi_{H,t-1} + \frac{(1-\theta_H)(1-\beta\theta_H)}{\theta_H(1+\beta\chi_H)}\left(mc_t - (p_{H,t} - p_t)\right)$$

- BGG4.26: $k_t = \delta inv_t + (1-\delta)k_{t-1}$

Base model (VIII)

- BGG4.27: $n_t = \frac{K}{N} rr_t^K - \left(\frac{K}{N} - 1 \right) \left(sp_{t-1} + i_{t-1} - \pi_t \right) + n_{t-1}$

- BGG4.28: $i_t = \rho_i i_{t-1} + (1-\rho_i)\left(\phi_\pi \pi_t + \phi_y y_t + \phi_{\Delta e} \Delta e_t \right) + z_t$

- BGG4.29: $\pi_t^w = \chi_w \pi_{t-1} + \frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w(1+\varepsilon_w \sigma_L)} \left(mrs_t - rw_t \right) + \beta E_t \left[\pi_{t+1}^w - \chi_w \pi_t \right]$

- BGG4.30: $\pi_t^w = rw_t - rw_{t-1} + \pi_t$

Base model (IX)

- BGG4.31: $g_t = \rho_g g_{t-1} + \varepsilon_{g,t}$
- BGG4.32: $a_t = \rho_a a_{t-1} + \varepsilon_{a,t}$
- BGG4.33: $z_t = \rho_z z_{t-1} + \varepsilon_{z,t}$
- BGG4.34: $y_{CO,t} = \rho_{yco} y_{CO,t-1} + \varepsilon_{yco,t}$

Base model (X)

- BGG4.35: $$i_t^* = \rho_{i*} i_{t-1}^* + \varepsilon_{i*,t}$$
- BGG4.36: $$\pi_t^* = \rho_{\pi*} \pi_{t-1}^* + \varepsilon_{\pi*,t}$$
- BGG4.37: $$\left(p_{CO,t}^* - p_t^*\right) = \rho_{pco*} \left(p_{CO,t-1}^* - p_{t-1}^*\right) + \varepsilon_{pco*,t}$$
- BGG4.38: $$y_t^* = \rho_{y*} y_{t-1}^* + \varepsilon_{y*,t}$$

Calibration (I)

Parameter	Value	Parameter	Value	Parameter	Value
β	0.995	(X-M)/Y	0.05	χ_w	1.0
σ	1	χ	0.5	ε_L	6.0
h	0.0	α_C	0.33	θ_F	0.875
σ_L	1	α_I	0.50	χ_F	1.0
α	0.34	η_C	0.50	ρ_i	0.0
δ	0.03	η_I	0.50	ϕ_π	1.50
G/Y	0.12	η^*	0.50	ϕ_y	0.125
ζ_{inv}	20	ζ	0.001	$\phi_{\Delta e}$	0.0
R^K	$(1/\beta+0.03)^{1/4}$	θ_H	0.75		
Def. rate	0.0075	χ_H	0.50		
Y_{CO}/Y	0.12	θ_w	0.8125		

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Calibration (II)

Parameter	Value	Parameter	Value
ρ_a	0.95	σ_a	0.7%
ρ_g	0.95	σ_g	1.5%
ρ_z	0.00	σ_z	0.25%
ρ_{i*}	0.97	σ_{i*}	0.25%
$\rho_{\pi*}$	0.55	$\sigma_{\pi*}$	0.125%
ρ_{pco*}	0.97	σ_{pco*}	13.0%
ρ_{yco}	0.95	σ_{yco}	4.0%
ρ_{y*}	0.85	σ_{y*}	1.0%

Calibration – Financial Contract

- Matlab codes BGG_ss.m y fun_bgg_ss.m are used to derive the reduced form parameters we use in the model, e.g., w.

- Some assumptions:

$$\ln(\omega) \sim N\left(-\frac{1}{2}\sigma_{\omega}^{2}, \sigma_{\omega}^{2}\right).\ \text{En EE}\ R^{K} - R = 0.03\ [\text{anual}]\ ,\ \int_{0}^{\overline{\omega}} f(\omega)d\omega = 0.0075,$$

$$\frac{K}{N} = 2, \gamma = 0.975$$

Dynare Code bgg4_model1.mod has these equations and calibration

```
model (linear);
// (BGG4.1)  Aggregate demand for Home goods
YH_Y*yh = ((1-alpha_C)*CCE_Y + (1-alpha_I)*I_Y)*dh + CHstar_Y*chstar + G_Y*g;
// (BGG4.2) Domestic and private demand for Home goods
((1-alpha_C)*CCE_Y + (1-alpha_I)*I_Y)*dh = (1-alpha_C)*C_Y*c + (1-alpha_C)*CE_Y*ce -(1-alpha_C)*(C_Y
// (BGG4.3) Foreign demand for Home goods
chstar = ystar - eta_star*(prh-rer);
// (BGG4.4) Volume of Imports
M_Y*m = alpha_C*C_Y*c + alpha_C*CE_Y*ce -alpha_C*(C_Y+CE_Y)*eta_C*(prf) + alpha_I*I_Y*(inv -eta_I*(p
// (BGG4.5) Volume of Exports
X_Y*x = CHstar_Y*chstar + YCO_Y*yco;
// (BGG4.6) Export deflator
X_Y*prx = CHstar_Y*prh + YCO_Y*(prcostar+rer);
// (BGG4.7) Dynamic definition of the real exchange rate
rer = rer(-1) + dep + pistar - pic;
// (BGG4.8) Dynamic definition of the price of Home goods
prh = prh(-1) + pih - pic;
// (BGG4.9). Uncovered interest parity condition
rnom = rnomstar + dep(+1) + varrho*bf;
// (BGG4.10). Balance of Payment:
BF_Y*(rer+bf) = BF_Y/beta_C*(rnomstar(-1) +(1+varrho)*bf(-1)+rer-pistar) + M_Y*(rer+m) + varphi*YCO_
// (BGG4.11) Imperfect exchange rate pass-through
pif = beta_C/(1+beta_C*chi_f)*pif(+1) + chi_f/(1+beta_C*chi_f)*pif(-1) + (1-theta_f)*(1-theta_f*beta
// (BGG4.12) Dynamic definition of the price of Foreign goods
prf = prf(-1) + pif - pic;
// (BGG4.13) Investment goods deflator
pri = (1-alpha_I)*prh + alpha_I*prf;
// (BGG4.14) Consumption goods deflator
0 = (1-alpha_C)*prh + alpha_C*prf;
// (BGG4.15) GDP definition
y = YH_Y*yh + YCO_Y*yco;
```

Continue

Modelo without financial accelerator, $sp_t = 0$ and $n_t = 0$

- We replace BGG4.19 and BGG4.27 by $sp_t = 0 \text{ y } n_t = 0$

- Implemented with a parameter FINACC
  - FINACC = 1: Equations BGG4.19 and BGG4.27 as in the base model
  - FINACC = 0: $sp_t = 0 \text{ and } n_t = 0$
- See code bgg4_model0.mod

```
parameters FINACC beta_C sigma h sigma_L alpha delta G_Y chi_inv RK YH_K ep

FINACC  = 0; //=1: under the financial accelerator; =0: w/o the financial accelerator

// (BGG4.19) Definition of the external spread
sp = FINACC*nu*(qr+k-n);

// (BGG4.27) Entrepreneur's networth evolution
n = FINACC*(K_N*rk - (K_N-1)*(sp(-1) + rnom(-1) - pic) + n(-1));
```

Model with dollarization

- Like in the base model FINACC = 1
- We replace BGG4.18 by

$$E_t\left[rr^K_{t+1} + \pi_{t+1} - i_{*_t} - \Delta e_{t+1}\right] =_t sp$$

- We also replace BGG4.27 by

$$n_t = \frac{K}{N} rr^K_t - \left(\frac{K}{N} - 1\right)\left(sp_{t-1} + i^*_{t-1} + \Delta e_t - \pi_t\right) + n_{t-1}$$

- See code bgg4_model2.mod

```
// (BGG4.18) spread of real return of capital over the cost of funds depend
rk(+1) - (rnomstar+dep(+1)-pic(+1)) = FINACC*sp;
```

```
// (BGG4.27) Entrepreneur's networth evolution. Dollarization
n = FINACC*(K_N*rk - (K_N-1)*(sp(-1) + rnomstar(-1) + dep - pic) + n(-1));
```

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A capital outflows can be modelled as an increase in the foreign interest rate or the sovereign risk premium ($i^* \uparrow$)

- Solve models and see responses of variable in ‘y’ to a foreign interest rate shock ‘y_e_rnomstar’

- Compare responses across models (base, w/o accelerator, and dollarized case) to the same increase of one standard deviation in the foreign interest rate

- Matlab code: TP6_2a.m
  - Solves the three models
  - Do the graphs of the variables for the three models

Code TP6_2a.m

- Solve three models:

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 0. Model without the financial accelerator
dynare bgg4_model0.mod
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 1. Model with the financial accelerator
dynare bgg4_model1.mod
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 2. Model with the financial accelerator and dollarization
dynare bgg4_model2.mod
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

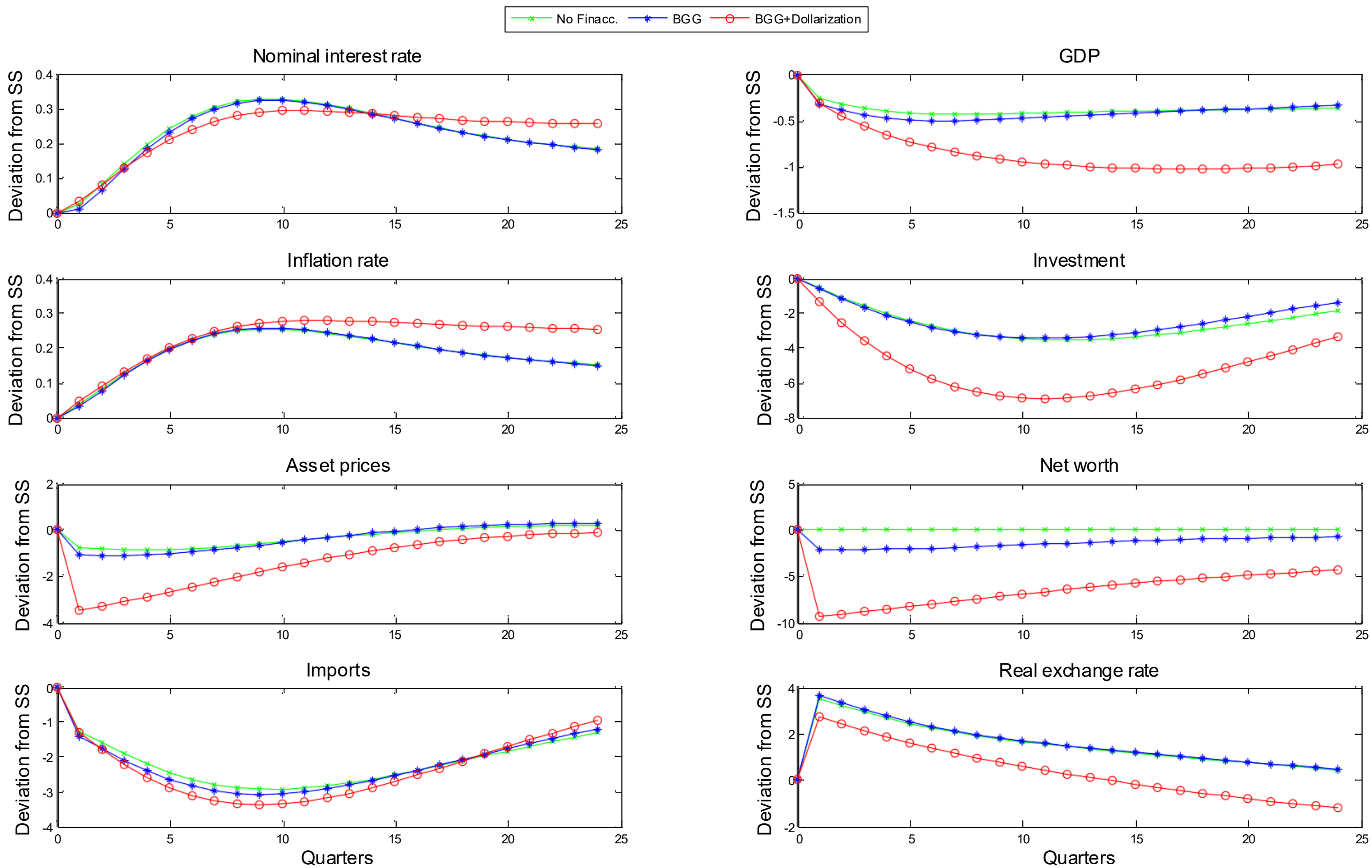
- Analyze the same increase in the foreign interest rate :

```
shock   = 'e_rnomstar';
size_shock = 1;
```

```
shock   = 'e_rnomstar';
size_shock = 1;
```

```
shock   = 'e_rnomstar';
size_shock = 1;
```

2.a Three models



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2.b Comparison between flexible ER and "managed float"

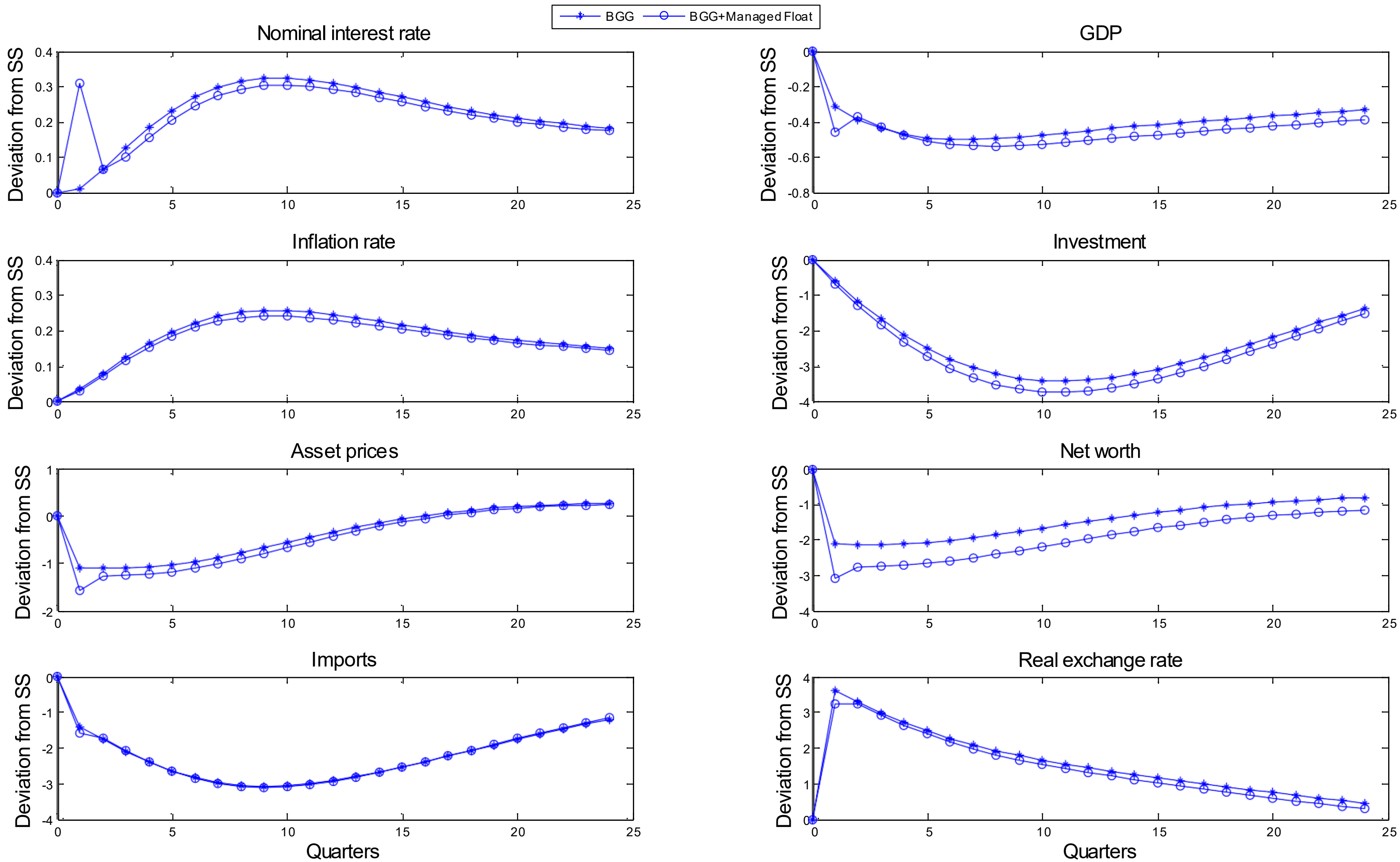
- Modify the calibration of the model: $\phi_{\Delta e}$ from 0 to 0.1.
  - $\phi_{\Delta e}$ = 0: fully flexible Exchange rate
  - $\phi_{\Delta e} \rightarrow \infty$: fixed Exchange rate
  - $\phi_{\Delta e} \neq 0$: some degree of Exchange rate management

- Code bgg4_model1a.mod equivalent to bgg4_model1.mod. Difference:

```
rho_i   = 0.80*0;
phi_pic = 1.5;
phi_y   = 0.125;
phi_dep = 0.10;
```

- Use Matlab code TP6_2b.m to make the comparison between models bgg4_model1.mod and bgg4_model1a.mod

2.b Comparison between flexible vs Managed Float



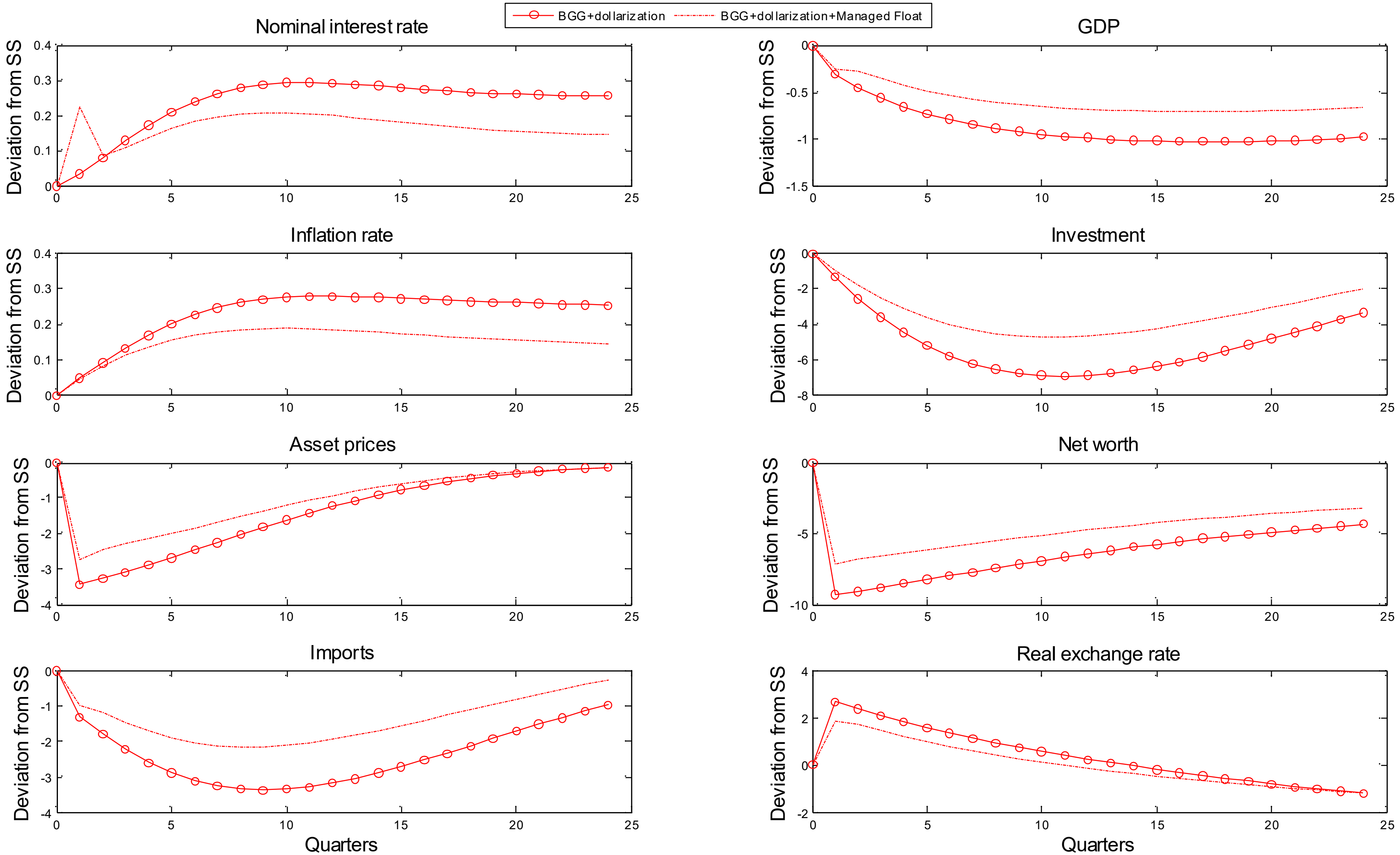
2.c Comparison between flexible vs Managed Float under dollarization

- Modify the calibration of the model: $\phi_{\Delta e}$ from 0 to 0.1.
- Code bgg4_model2a.mod equivalent to bgg4_model2.mod. Difference:

```
rho_i   = 0.80*0;
phi_pic = 1.5;
phi_y   = 0.125;
phi_dep = 0.10;
```

- Use Matlab code TP6_2c.m to compare between models bgg4_model2.mod and bgg4_model2a.mod

2.c Comparison between flexible vs Managed Float under dollarization



2.d Introducing macroprudential policy

- Let’s introduce a capital flows tax. Now the interest parity condition (BGG4.) is:

$$i_t = i_t^* + E_t\left[\Delta e_{t+1}\right] + \zeta b_t^* + \underbrace{\zeta_{\Delta b^*}\left(b_t^* - b_{t-1}^*\right)}_{tax}$$

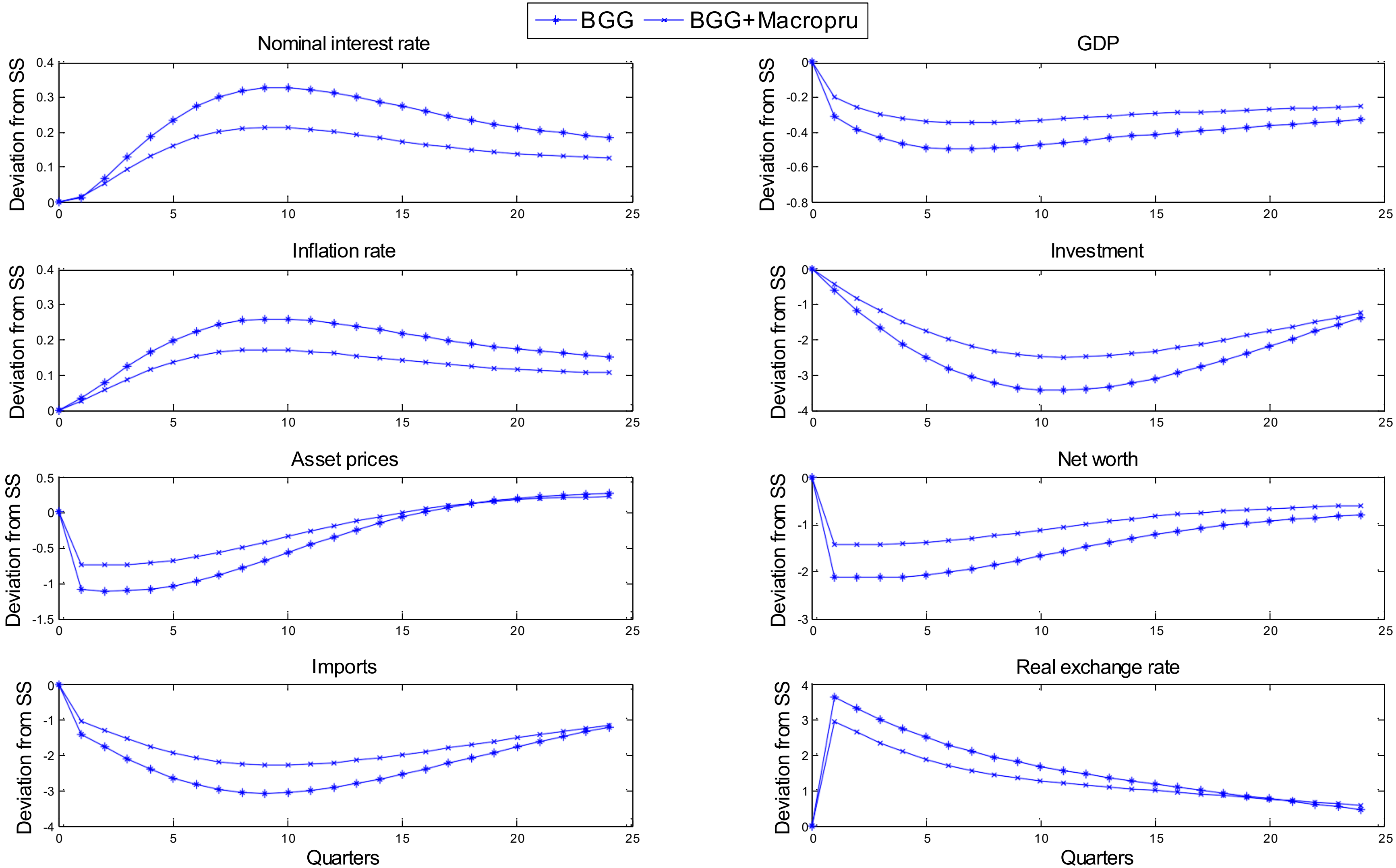
- Code bgg4_model1b.mod equivalent to bgg4_model1.mod, but includes the new tax parameter and modify the IRP condition:

```
parameters theta_h chi_h theta_f chi_f rho_i phi_pic phi_y phi_dep chi_dbf rho_a rho_g rho_z;
```

```
// (BGG4.9). Uncovered interest parity condition
rnom = rnomstar + dep(+1) + varrho*bf + chi_dbf*(bf-bf(-1));
```

- Run the Matlab code TP6_2d.m

2.d Comparison: base model versus model with macroprudential policy



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2.e Macroprudential Policy and Dollarization

- Again we consider taxes to the capital flows,

$$i_t = i_t^* + E_t\left[\Delta e_{t+1}\right] + \zeta b_t^* + \underbrace{\zeta_{\Delta b^*}\left(b_t^* - b_{t-1}^*\right)}_{tax}$$

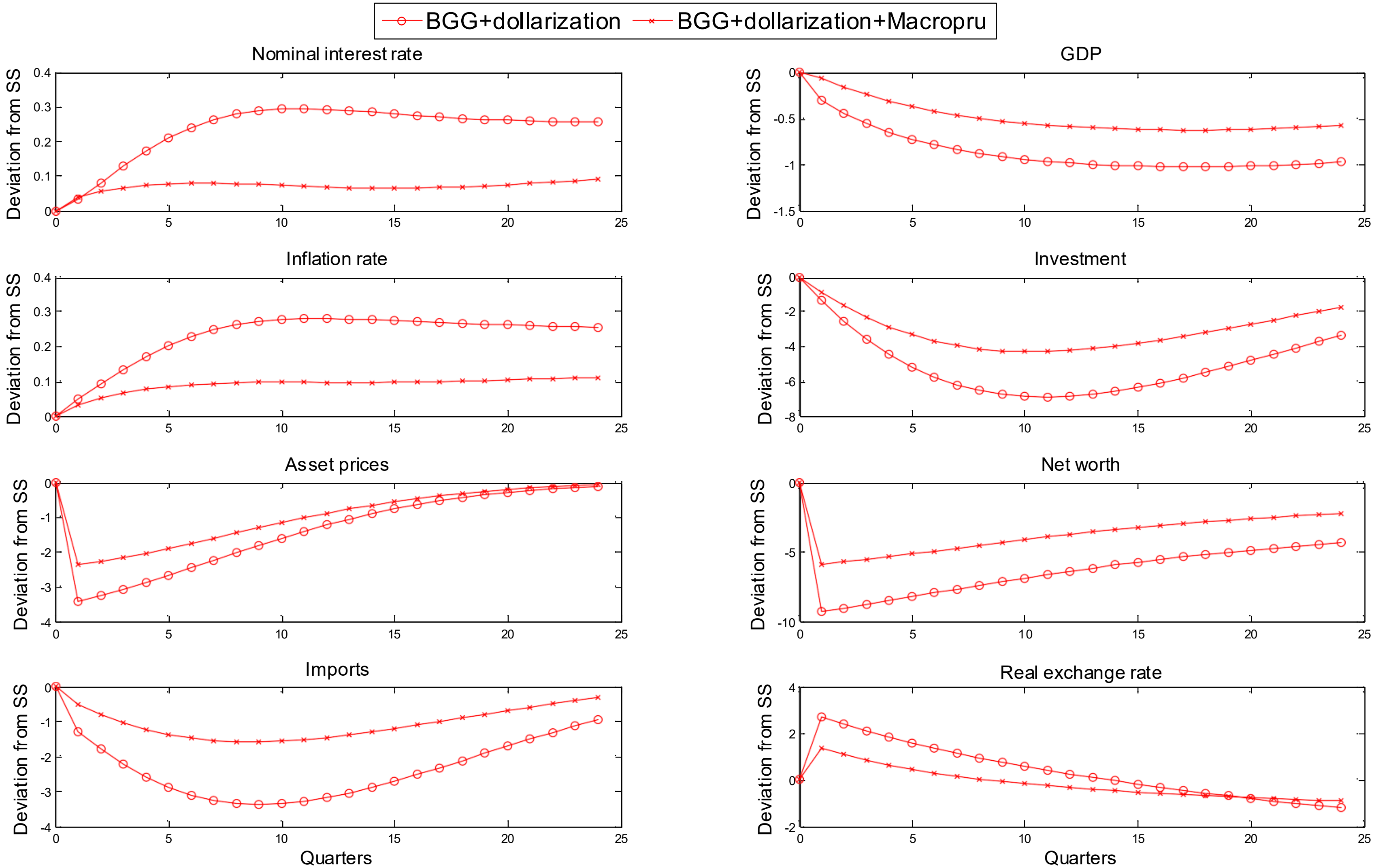
- Code bgg4_model2b.mod is equivalent to bgg4_model2.mod, but including the new parameter and modify the IRP condition

```
parameters theta_h chi_h theta_f chi_f rho_i phi_pic phi_y phi_dep chi_dbf rho_a rho_g rho_z;

// (BGG4.9). Uncovered interest parity condition
rnom = rnomstar + dep(+1) + varrho*bf + chi_dbf*(bf-bf(-1));
```

- Run Matlab code TP6_2e.m

2.e Macroprudential Policy and Dollarization



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Final Comments

- Contraction of GDP could be worse in an economy with financial accelerator mechanism. This effects is magnified when the economy is dollarized.
- However, it is highly recommended to have flexible exchange rate instead of fixed exchange rate (but must be cautious when economies are highly dollarized).
- A macroprudential policy seems to have positive effects (help to minimize contractions) in an economy facing capital flights.