Financial Instability and Optimal Monetary Policy

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Introduction I

- Various variables are often studied for financial stability issues:
  1. House prices
  2. Financial assets prices
  3. Households debt growth

- The main question which is addressed in this study:

  What is the optimal monetary policy rule for the central bank to prevent financial instability?

Introduction II

- Asset price up-swing may lead to a bubble in the market
- The rise of asset prices and then the return of assets increases the demand for assets
- This prompts investors to borrow more to finance further capital accumulation
  - Debt accumulation
- In this model:
  - Financial imbalances is defined as a function of debt ratio (outstanding debt accumulation over the domestic output) and exchange rate

Motivation and some related literatures

- An optimal monetary policy for small open economies when central banks care about the financial imbalances.
- Gali and Monacelli (2005): Equilibrium dynamics in terms of domestic inflation and output gap for a small open economy.
- Divino (2009):optimal monetary policy rules for a small open economy (indirect response to exchange rate).
- Bean (2004): Financial instability and monetary policy: An ad hoc model, not for open economies.
- Closed economy- based models.

The Exchange Rate Role

- Nominal exchange rate is defined as the home price of the foreign country currency.
- The good effect of Exchange rate depreciation :
  - Reinforcement of the firm's competitiveness.
- The bad effect of devaluation :
  - Raising imported inflation and positive effect on CPI (consumer price index).
- So, exchange rate plays a significant role in national economy.

Financial Stability

- Oscillation of asset prices is the core concept in financial stability studies.
- The Central Bank:
  - may care directly about the oscillation of the exchange rate in some small open economies
  - may think more about the exchange rate depreciation than appreciation because of inflation
- The effects of devaluation on the national economy lead to changes in:
  - the financial state of households
  - domestic productivity
  - financial state of firms through inflation

Economy Model - Households Sector I

- Representative household's utility function:

$$\text{Max Et} \sum_{k=0}^{\infty} \beta^k \left[U\left(C_{t+k}, \frac{M_{t+k}}{P_{t+k}}\right) - \frac{N_{t+k}^{1+\delta}}{1+\delta}\right]$$

$$U\ (Ct+k,\ Mt+k/Pt+k) = \frac{C_{t+k}^{1-\sigma}}{1-\sigma} + \chi(M_{t+k}/P_{t+k})^{\gamma}/1-\gamma$$

The budget constraint:

$$P_t C_t + V_{t,1} F_t + M_t + \vartheta_t V_{t,1}^{*} F_t^{*} \leq W_t N_t + \Pi_t + F_{t-1} + M_{t-1} + \vartheta_t F_{t-1}^{*} + T_t$$

First Order Conditions

$$V_{t,1} = \beta\left(\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{P_t}{P_{t+1}}\right)$$

$$V_{t,1}^{*}\,\vartheta_t\,C_t^{-\sigma} = \beta\left(C_{t+1}^{-\sigma}\,\vartheta_{t+1}\,\frac{P_t}{P_{t+1}}\right)$$

$$C_t^{-\sigma}\left(\frac{W_t}{P_t}\right) = N_t^{\delta}$$

It is assumed that the foreign country has the same Euler equation as the home country

$$V_{t,1}^{*} = \beta\left(\frac{C_{t+1}^{*}}{C_t^{*}}\right)^{-\sigma}\left(\frac{P_t^{*}}{P_{t+1}^{*}}\right)$$

Household Sector II

- Nominal exchange rate can be written in a log-linear form:

$$e_t - E_t e_{t+1} = i_t^* - i_t + \varsigma_t$$

- Where, $e_t = log(\vartheta_t)$, $i_t \simeq \log(1 + i_t)$.
- The common assumption is that there is no arbitrage in international financial markets.
- Thus, e_t is the nominal uncovered interest rate parity (UIP)

Definition of some aggregators

- $P_{h,t} = [\int_0^1 P_{h,t}^{1-\varepsilon}(j)dj]^{\frac{1}{1-\varepsilon}}$: Domestic price of home produced good i.e. producer price index (PPI) .
- $P_{f,t} = [\int_0^1 P_{f,t}^{1-\varepsilon}(j)dj]^{\frac{1}{1-\varepsilon}}$:Home price of foreign produced good.
- $\varepsilon > 1$ is the elasticity of substitution across goods in a country.

Household Sector III

- It is assumed that real exchange rate can be written as (Chari, Kehoe and McGrrattan (1997, 2002):

$$q_t = e_t + P_t^* - P_t$$

- Terms of trade is defined as:

$$S_t = \frac{P_{f,t}}{P_{h,t}}$$

Household Sector IV

- Thus, the relation between real exchange rate and terms of trade can be derived as :

$$q_t = s_t + p_{h,t} - p_t$$
$$= (1 - \alpha)\, s_t$$

- This comes from the definition of terms of trade and the relation between real and nominal exchange rate (in log-linear form)
- α is the degree of openness of the economy.

Economy Model - Firms Sector I

- The firm uses the labor- based production function to produce differentiated good j as: $Y_t(j) = A_t N_t(j)$
- As Gali and Monacelli (2005) discuss, the aggregate relation for the output can be written as $y_t = n_t + a_t$ in log-linear form.
- From the assumptions of $C_t^* = C_{f,t}^*$ and $P_t^* = P_{f,t}^*$ and from $c_t = c_t^* + \frac{1}{\sigma} q_t$ which is derived from the Euler equations of domestic and foreign economy, the following relation can be derived:

$$y_t = y_t^* + \frac{1}{\sigma}(\psi s_t)$$

Firms Sector II

- From the equilibrium condition for foreign country and consumption, real exchange rate relationships and the previous equation the following relationship can be deduced:

$$c_t = \omega y_t + (1 - \omega) y_t^*$$

- Where $\omega = \frac{1 - \alpha}{\psi}$ and $\psi = 1 + \alpha(2 - \alpha)(\sigma\varphi - 1)$

- Domestic output equation indicates that it is related positively to foreign output and terms of trade.

Firms Sector III

- Marginal cost:
  - The real marginal cost of the technology which is used by firms is given by: $m_t = w_t - a_t - p_t$

- Using equations of consumption, the optimal condition of labour supply of household [log-linear form], and the relation between CPI and domestic prices, the real marginal cost of the firm can be rewritten as:

$$m_t = (\delta + \sigma\omega)y_t + \sigma(1-\omega)y_t^* - (1+\delta)a_t^f$$

Financial Imbalances

- In order to show the financial imbalances effect in the model, domestic productivity is set equal to the state of technology and whether or not financial imbalances exist. Thus, domestic productivity and financial imbalances are defined respectively, as:

$$a_t^f = b_t - [\lambda_1(d_t - y_t) + \lambda_2 q_t]$$

$$f_t = \lambda_1(d_t - y_t) + \lambda_2 q_t$$

- f_t denotes financial imbalances which is a function of outstanding debt relative to the domestic output and real exchange rate.

Dynamics of Domestic Output

- Using the equation of domestic consumption and consumption Euler equation dynamics of domestic output can be read as:

$$y_t = Ey_{t+1} - \frac{1}{\sigma_c}\left[i_t - E\pi_{h,t+1} - \rho\right] + (\psi - 1)E\Delta y^*_{t+1}$$

- We used the formal assumption that $V_{t,1} = \frac{1}{R_t}$ and $R_t = 1 + i_t$

  R_t is the gross nominal interest rate

Where $\sigma_c = \frac{\sigma}{\psi}$ and $\rho = -log\beta$.

Dynamics of Inflation I

- Firms are assumed to set price according to Calvo (1983)
- (1-θ) is the probability that a firm resets its price in a given period.
- Following Calvo price setting and after deriving the mark-up, domestic inflation can be written as:

$$\pi_{h,t} = \beta E_t \pi_{h,t+1} + \Omega \overline{m_t}$$

- Where $\Omega = \theta^{-1}(1-\theta)(1-\beta\theta)$ and $\overline{m_t}$ is the deviation of real marginal cost from the marginal cost under fully flexible price condition.

Dynamics of Inflation II

- Let $\lambda_2 = \frac{\alpha}{(1+\delta)(1-\alpha)}$: The weight on the real exchange rate in financial imbalances equation.
- Then from the real marginal cost ,the dynamics of the domestic inflation can be derived as:

$$\pi_{h,t} = \beta E_t \pi_{h,t+1} + M x_t + \Lambda q_t$$

- Where M= $\Omega\Phi$, $\Lambda = \Omega\frac{\alpha}{1-\alpha}$ and $\Phi = (\delta + \sigma\omega)$.

The IS Curve - Aggregate Demand Equation

- From the optimal domestic output relation and terms of trade definition, the output gap can be written as:

$$x_t = E_t x_{t+1} - \frac{1}{\sigma_c}\left[i_t - E_t \pi_{h,t+1} - \overline{r_t}\right]$$

Where, $\sigma_c = \frac{\sigma}{\psi}$, $\overline{r_t} = \rho + \sigma_c \Gamma \Delta E_t y^*_{t+1} - (\frac{(1+\delta)\sigma_c}{\Phi})(1-\rho_a)a^f_t$ and

$$\Gamma = \left(\frac{\Phi(\psi - 1) - \sigma(1-\omega)}{\Phi}\right)$$

Financial Imbalances and central banks

- The central bank thinks about taking a policy to prevent instability in the economy and may care about the financial imbalances for this purpose.
- Let, ρ_f, normalized between zero and one, indicates the severity of financial imbalances effects on labour productivity and then firm's real marginal cost then we have:

$$a_t^f = b_t - \rho_f \left[\lambda_1 (d_t - y_t) + \lambda_2 q_t \right]$$

$$= b_t - \rho_f f_t$$

$$f_t = [\lambda_1 (d_t - y_t) + \lambda_2 q_t]$$

Economy Instability

- Now, let $\widehat{y_t}$ be the feasible output target that the central bank looks for when domestic productivity is not affected by the financial imbalances, $\widehat{y_t} = \text{v}\,[b_t - \Gamma_1 y_t^*]$ where,

$$\text{v} = \frac{(1+\delta)}{\Phi} \qquad \Gamma_1 = \frac{\sigma(1-\omega)}{(1+\delta)}$$

- Then, the output gap increases by $\text{v}\rho_f f_t$:

$$x_t^* = (\,y_t - \overline{y_t}\,) + (\,\overline{y_t} - \widehat{y_t}\,)$$
$$= x_t + \text{v}\,[a_t^f - \Gamma_1 y_t^*] - \text{v}[b_t - \Gamma_1 y_t^*]$$
$$= x_t - \text{v}\rho_f f_t$$

Financial Imbalances and Optimal Monetary Policy I

- The policy maker seeks to set appropriate interest rate to stabilize the economy when there are financial imbalances

- The period loss function can be written as :

$$L_t = (\pi_{h,t})^2 + \gamma_x(\,xt)^2 + \gamma_i\,(i_t - \bar{\imath})^2$$

- Where, $\gamma_x = \frac{\big((1+\delta)-(1-\sigma)\omega\big)(1-\theta)(1-\theta\beta)}{\theta\varepsilon}$ which is coming from the welfare function following Woodford (2003) and Rotemberg and Woodford (1998,1999) and setting the target of inflation to zero.

Optimal Monetary Policy II

- The problem is: $Min\ E_0 \sum_{k=0}^{\infty} \beta^k L_{t+k}$ subject to :

$$L_t = (\pi_{h,t})^2 + \gamma_x(\text{xt})^2 + \gamma_i\ (i_t - \bar{\imath})^2$$

$$q_t = E_t e_{t+1} + i_t^* - i_t + p_t^* - p_t$$

$$\pi_{h,t} = \beta E_t \pi_{h,t+1} + M x_t + \Lambda q_t$$

$$x_t^* = x_t - \text{v}\rho_f f_t$$

- The Lagrangian technique which is implied in Woodford (2003) is used to reach the solution.

Optimal Monetary Policy Rule I

- The optimal monetary policy rule under commitment, therefore, can be written as:

$$i_t = \varphi_{0,i}\bar{\imath} + \varphi_{1,i}i_{t-1} - \varphi_{2,i}i_{t-2} + \varphi_\pi \pi_{h,t} + \varphi_{o,x}\left(x_t^* + V\rho_f f_t\right) - \varphi_{1,x}x_{t-1}$$

$$\varphi_{0,i} = 1 - \left(\frac{1}{\beta} + \frac{1}{(1+\Omega\alpha)} + \frac{1}{\sigma_c(1+\Omega\alpha)} - \frac{1}{\beta(1+\Omega\alpha)}\right)$$

$$\varphi_{1,i} = \frac{1}{\beta} + \frac{1}{(1+\Omega\alpha)} + \frac{1}{\sigma_c(1+\Omega\alpha)}$$

$$\varphi_{2,i} = \frac{1}{\beta(1+\Omega\alpha)} \qquad \varphi_\pi = \frac{M}{\sigma_c\gamma_i(1+\Omega\alpha)} \qquad \varphi_{o,x} = \frac{\gamma_x}{\sigma_c\gamma_i}$$

$$\varphi_{1,x} = \frac{\gamma_x}{\sigma_c\gamma_i(1+\Omega\alpha)}$$

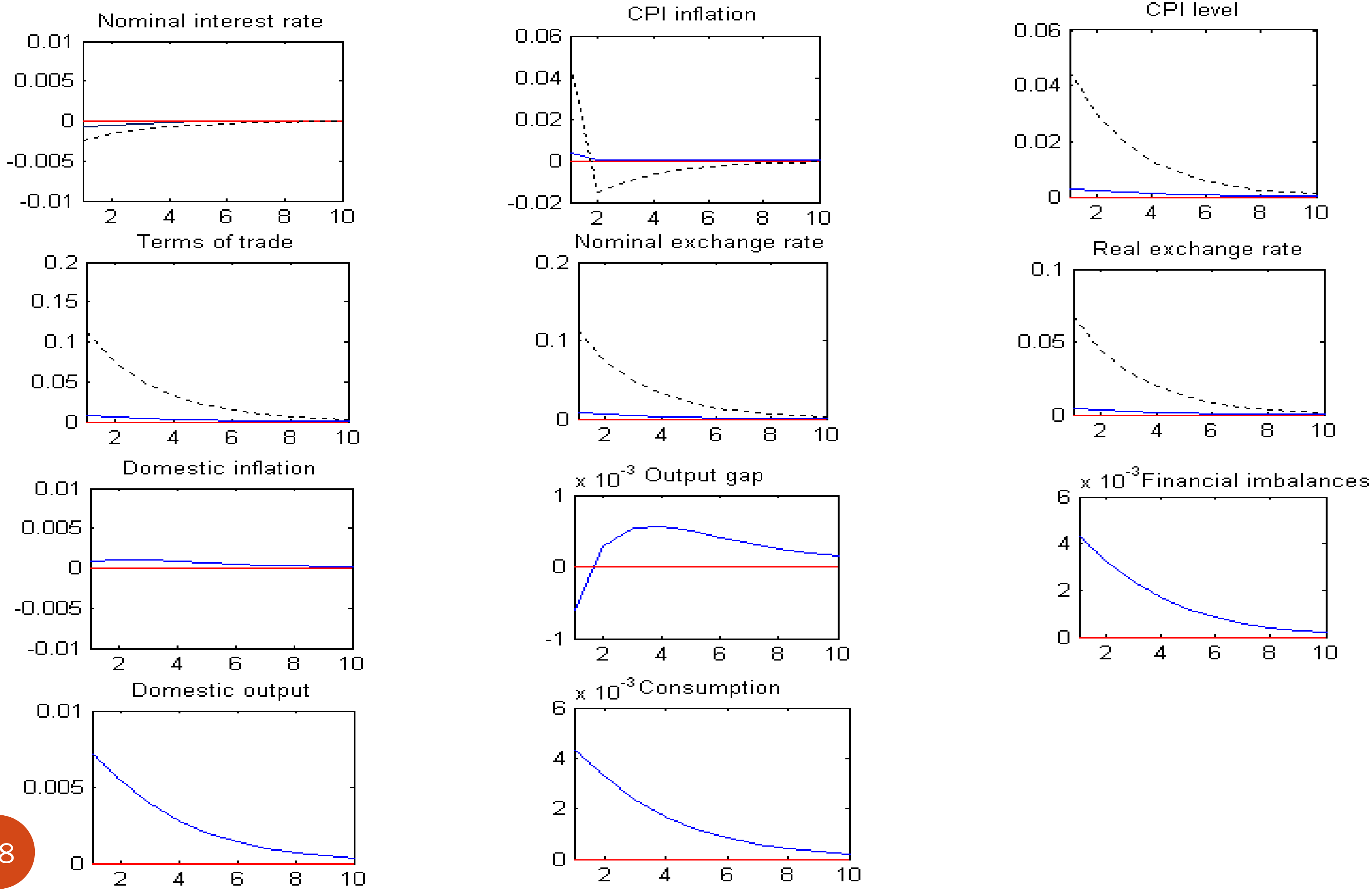
Optimal Monetary Policy Rule II

- From the optimal policy rule, the monetary policy responds to the movement of exchange rate indirectly, through the domestic output and inflation.
- The policy rule reacts directly to financial imbalances .
- With existence of financial imbalances, the monetary policy maker responds to the real exchange rate movements directly.
- Changing of the nominal interest rate in response to devaluation in a situation where financial imbalances may occur, can prevent probable future imbalances and instabilities.

Impulse Responses(comparative analysis)

- The dynamic effects of domestic productivity and foreign output shocks on some variables are investigated.
- With an innovation to the domestic productivity, nominal interest rate remains more stable under the model's optimal rule compared to optimal policy in Gali and Monaceli (2005) (GM).
- The fall in nominal interest rate in both models supports the increase of output and consumption.
- Output gap falls in the first two periods.
  - then increases because of an increase in the real exchange rate

Impulse responses to a domestic productivity shock under optimal policy in GM (2005) (Dashed line) and Derived optimal policy rule in present model (solid line)



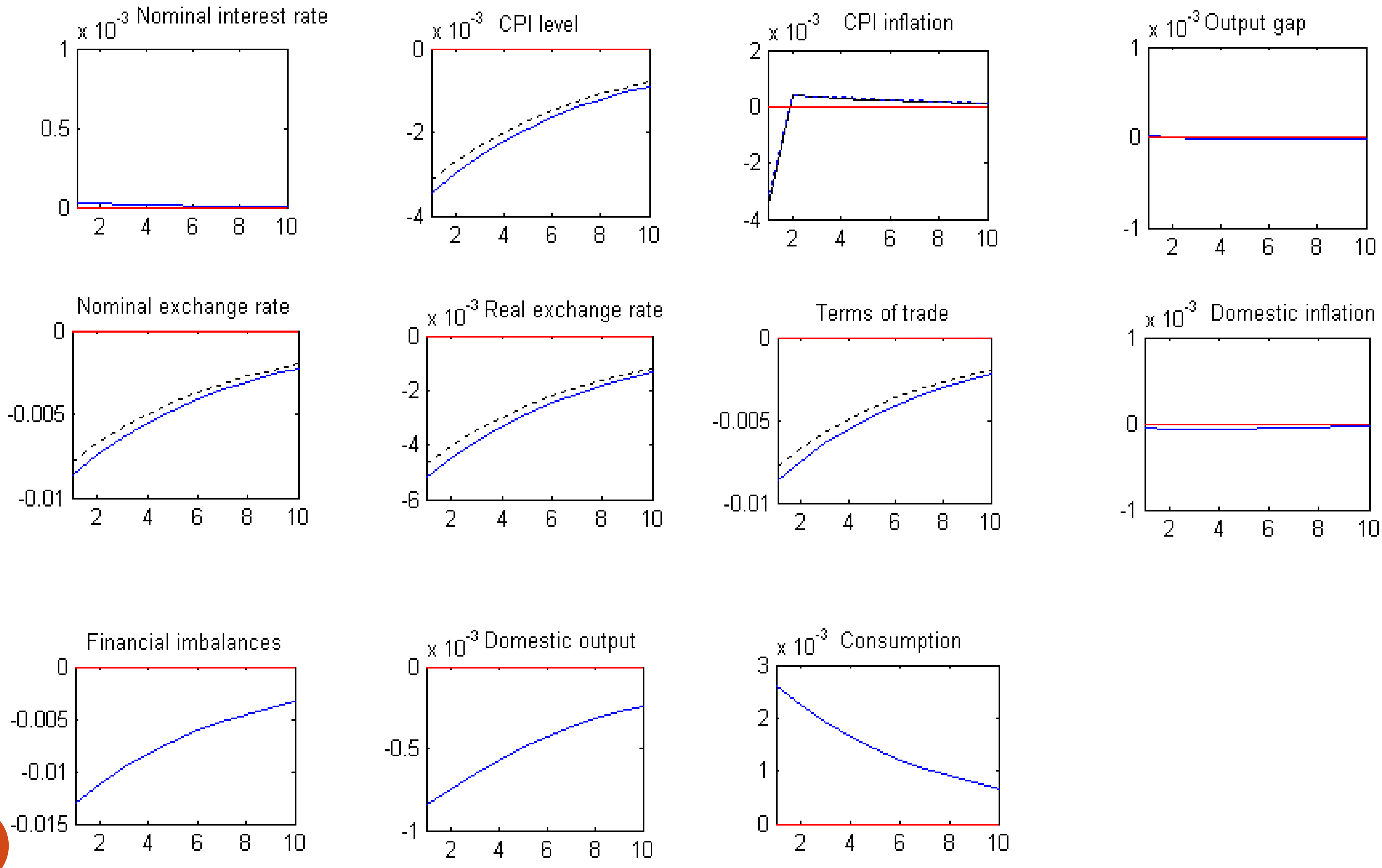
Impulse Responses to a Domestic Productivity Shock

- With a shock to the domestic productivity, domestic output and consumption increases
  - as a result exchange rate increases a little through the fall in domestic nominal interest rate, resulting from uncovered interest parity which leads to a rise in financial imbalances
- This is because of an increase in imported inflation which have a positive effect on the CPI and then on the imbalances of households’ financial state
- Exchange rate depreciation, that is more expensive imported items may lead to:
  - perhaps more household debt accumulation relative to the domestic output
  - Imbalances in financial state of households and firms.

Impulse Responses to a Foreign Output Shock

- The shock leads to a fall in real and nominal exchange rates
  - In fact, with a shock to the foreign output, consumption increases, whereas domestic output falls
- Exchange rate decreases through the rise in domestic nominal interest rate
- CPI level and CPI inflation fall and stay below those in GM
- Output gap seems to remain stable in response to the foreign output shock in both models
- Financial imbalances decrease through the fall in real exchange rate and CPI

Impulse responses to a foreign output shock under optimal policy in GM (2005) (Dashed line) and derived optimal policy rule in present model (solid line)



Summary and Conclusion I

- In this model:
  - I investigate the effect of financial instability on the optimal monetary policy rule
  - financial imbalances is defined as a function of debt ratio (outstanding debt accumulation over the domestic output) and real exchange rate

- The effects of devaluation on the national economy lead to changes in:
  - the financial state of households
  - domestic productivity
  - financial state of firms through inflation

- Optimal monetary policy rule under commitment responds directly to the real exchange rate changes in condition of financial imbalances.

Conclusion II

- The higher is financial imbalances, the central bank sets higher nominal interest rate.
- With a shock to the domestic productivity, exchange rate increases a little through the fall in domestic nominal interest rate, resulting from uncovered interest parity which leads to a rise in financial imbalances.
- With a shock to the foreign output, Financial imbalances decrease through the fall in real exchange rate and CPI.

Thank you!