MPC in DSGE models

Vadim Artemov, Skoltech

24 May 2022, Moscow

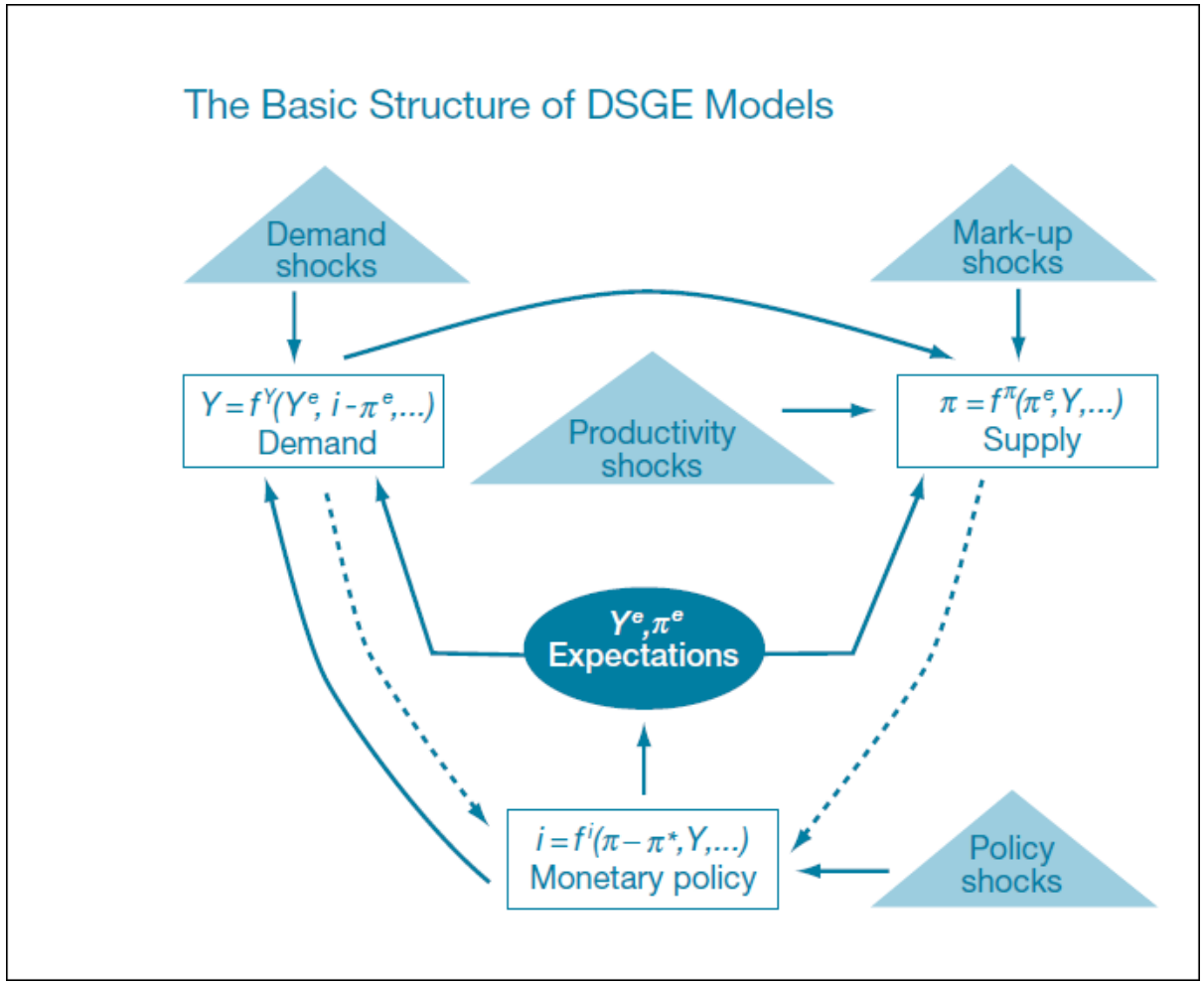
Summary

- Developed a DSGE model environment
- Implemented a way to control the system via the interest rate
- Analysed simple policies
- Developed MPC for the setting

DSGE in brief

- Allows for explicit simulation of agents' actions
- Stochastic, dynamic, general
- Can be linearized to get less computationally intensive solution:

$$y_t = E_t y_{t+1} - (r_t - \bar{r}) + g_t$$
$$i_t = r_t + E_t \pi_{t+1}$$
$$i_t = \bar{r} + \pi^T + \phi_\pi \left(\pi_t - \pi^T\right) + \phi_y \left(y_t - \bar{y}\right) + v_t$$
$$\pi_t - \pi^T = \beta \left(E_t \pi_{t+1} - \pi^T\right) + \kappa (y_t - \bar{y}) + u_t,$$



Source: Sbordon et. al. 2010

Problem studied: main issues

- This is a linear system: convergence depends on the initial condition
- How to optimally conduct monetary policy?
- Is it possible to use MPC at all?

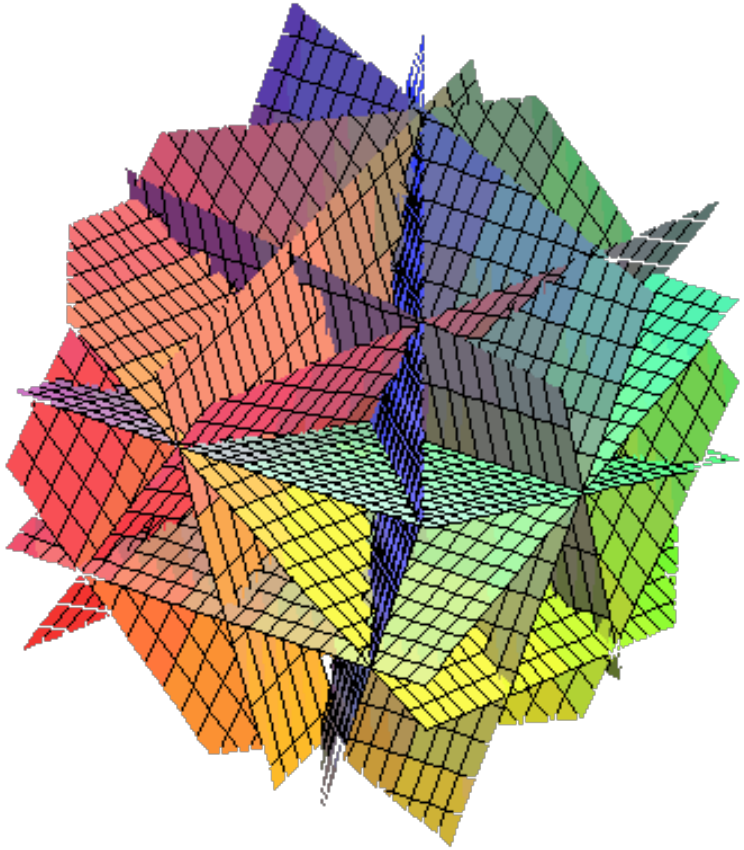
$$\sum_{t=0}^{n} (\pi_i - \pi^T)^2 + (y_i - y^T)^2 \to \min_i$$

s.t.

$$y_t = E_t y_{t+1} - (r_t - \bar{r}) + g_t$$

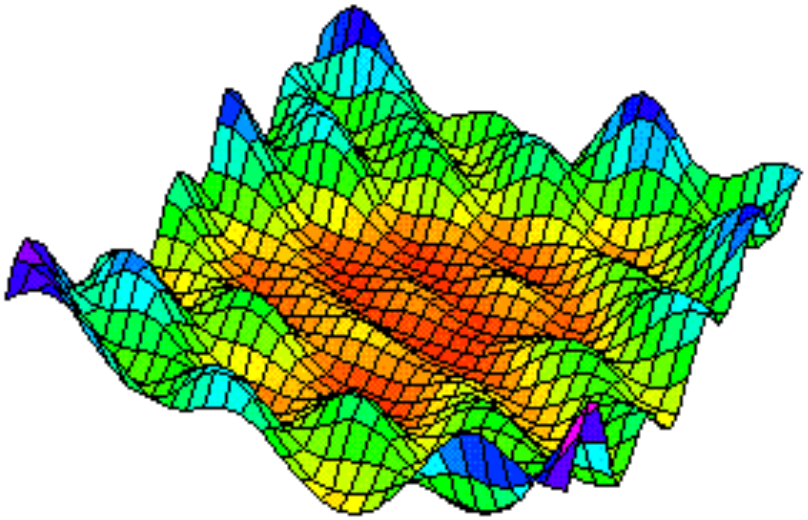
$$i_t = \bar{r} + \pi^T + \phi_\pi \left(\pi_t - \pi^T\right) + \phi_y \left(y_t - \bar{y}\right) + v_t$$

$$\pi_t - \pi^T = \beta \left(E_t \pi_{t+1} - \pi^T\right) + \kappa(y_t - \bar{y}) + u_t,$$

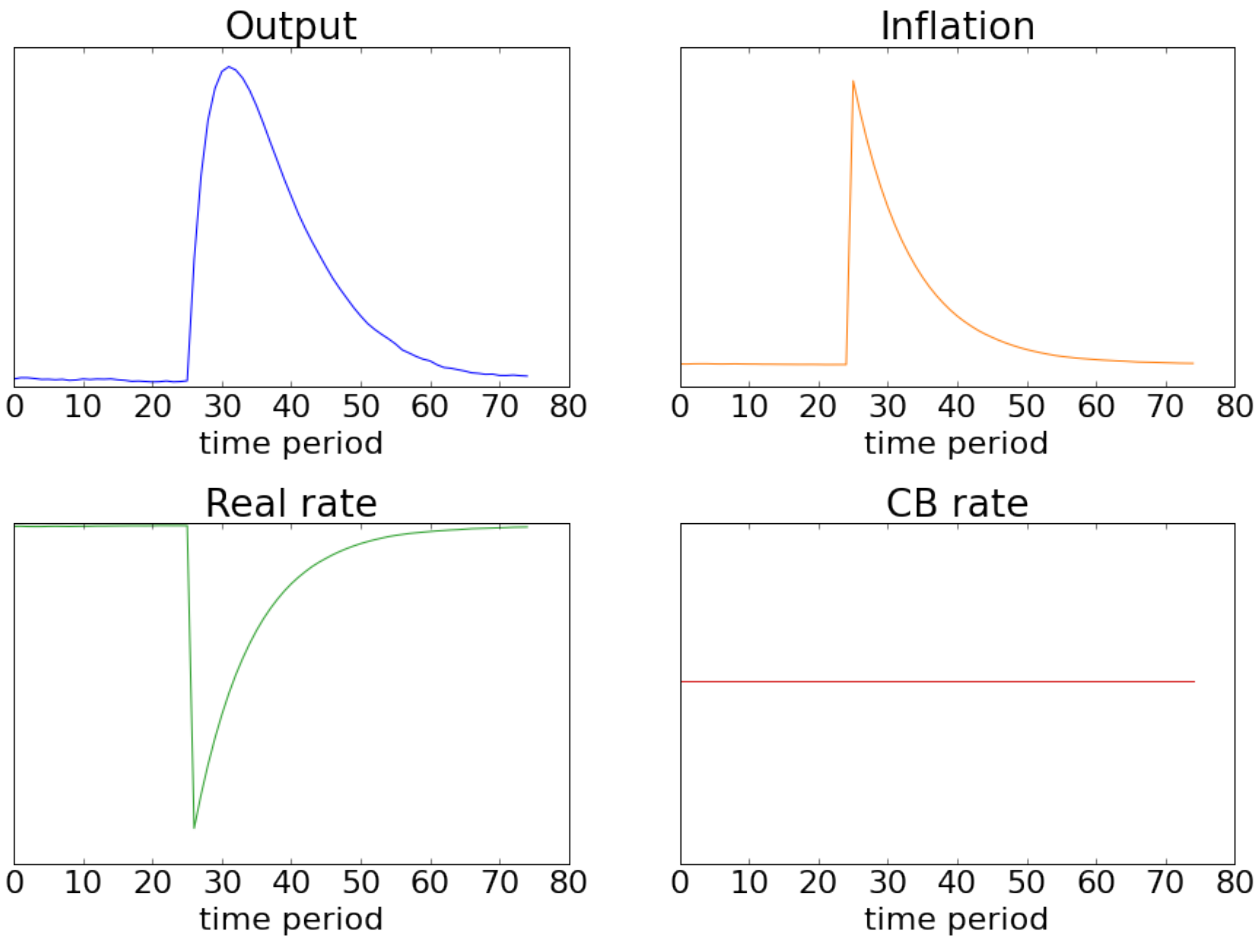


Methods used

- Combinatorial selection of coefficients
- Forward and current estimation of coefficients
- Automatic and manual minimisation of the loss function
- MPC



No policy:

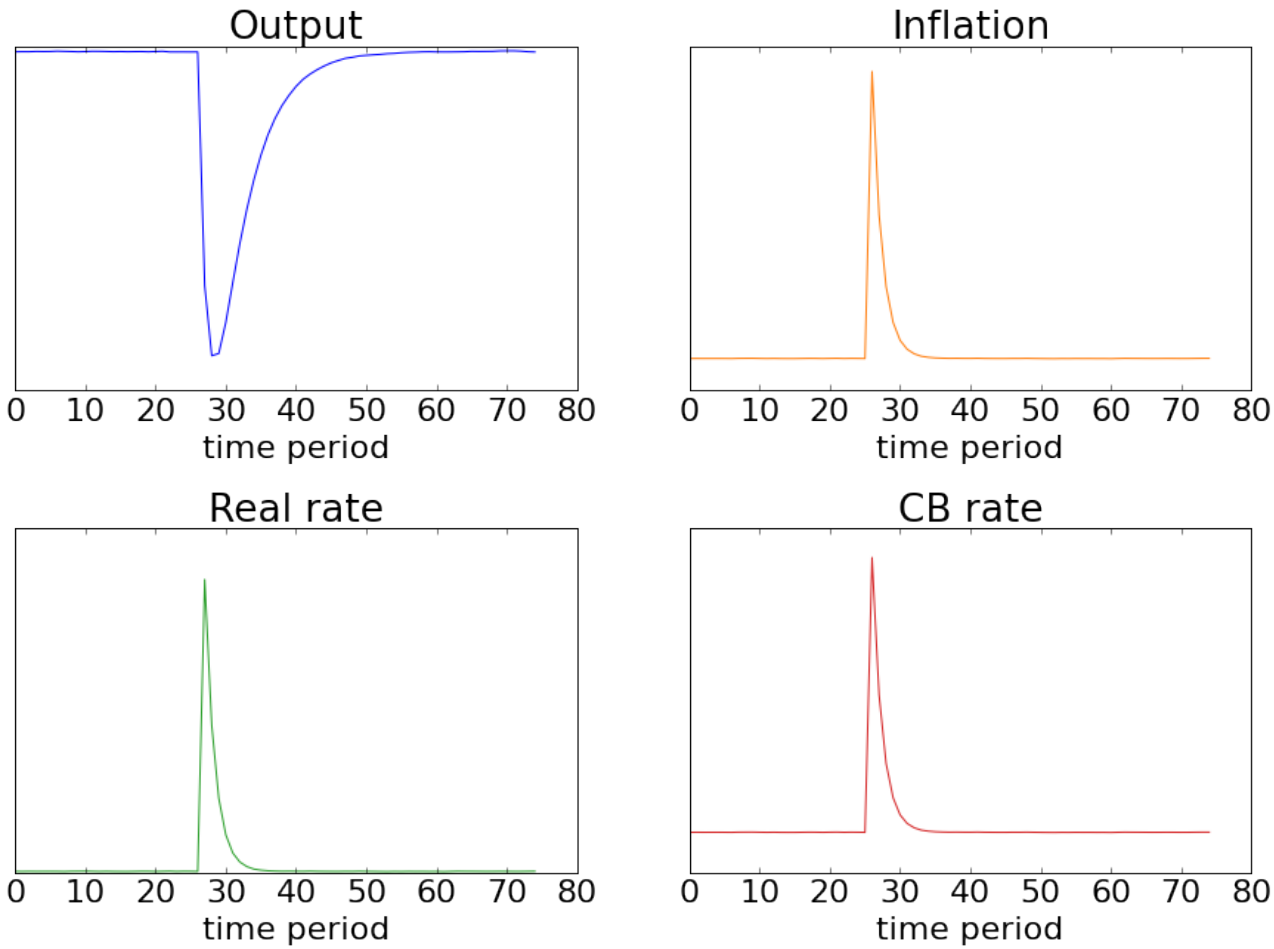

Output
0 10 20 30 40 50 60 70 80
time period
Inflation
0 10 20 30 40 50 60 70 80
time period
Real rate
0 10 20 30 40 50 60 70 80
time period
CB rate
0 10 20 30 40 50 60 70 80
time period

Results

- Model converges and works
- Policy works
- Control is implemented

Type	Loss
No policy	142.16
Simple policy	47.66
Control	40.23

With policy:


Output
0 10 20 30 40 50 60 70 80
time period
Inflation
0 10 20 30 40 50 60 70 80
time period
Real rate
0 10 20 30 40 50 60 70 80
time period
CB rate
0 10 20 30 40 50 60 70 80
time period

Conclusion:

- DSGE model environment works and converges
- Several control methods implemented
- MPC is developed for this setting
- MPC works slightly better than standard policy