A DSGE model of the Czech Republic:

a Ministry of Finance approach

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Moderni nastroje pro financni analyzu a modelovani

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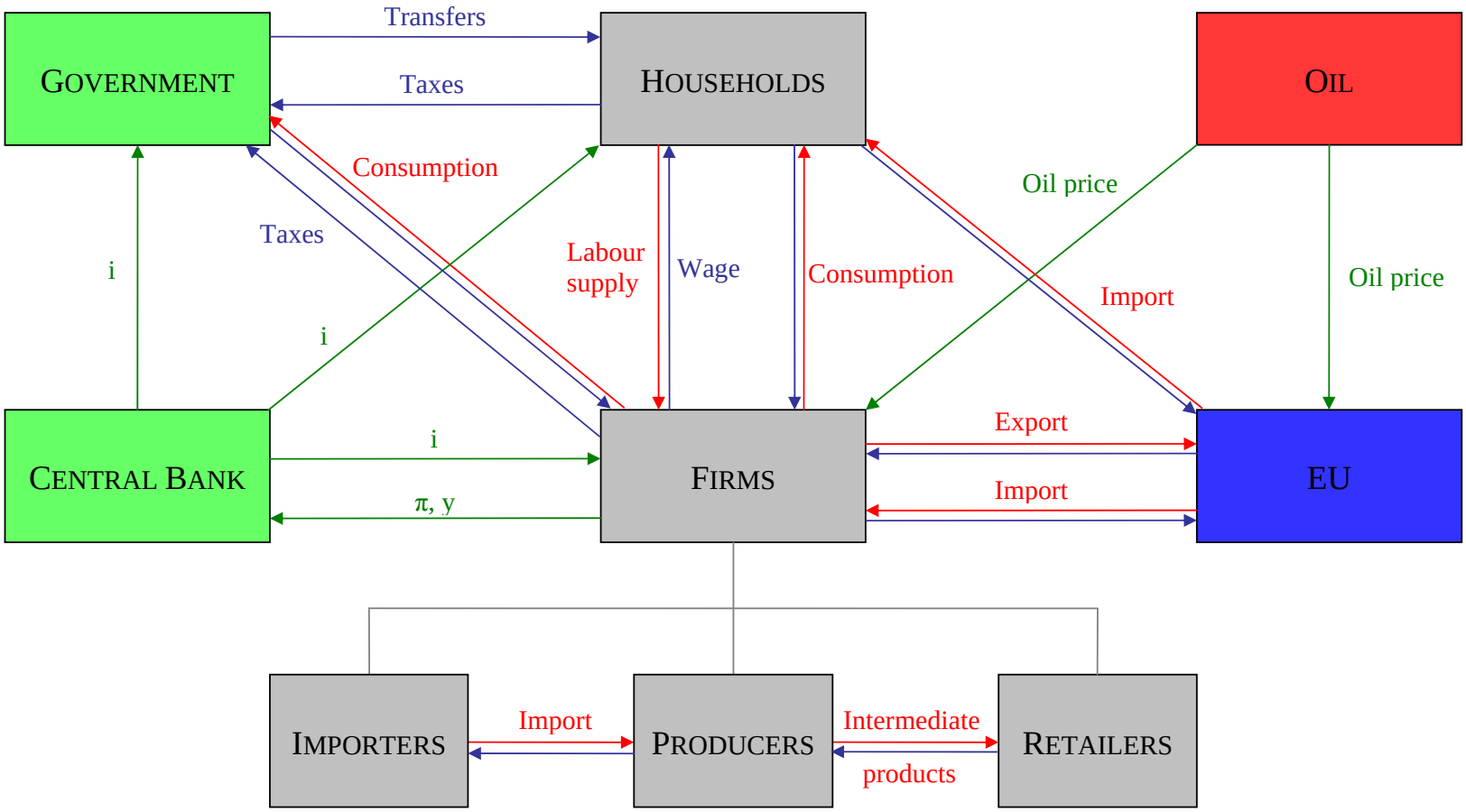
Outline

- Why economic modelling at the Ministry of Finance;
- Structure of the model;
- Technical solution;
- Simulation results;
- Conclusion and next steps...

Modelling purposes at the MoF

- Macroeconomic forecasts - model scenario.
- Simulations: Convergence Program, ad hoc analysis:
  - changes in foreign or home GDP,
  - foreign demand effects,
  - fiscal policy measures.
- First step was to build a simple model,
- Model has been extended – with emphasis on fiscal policy,
- Further steps will follow.

Structure of the model



Households

Specification:

- infinitely lived agents,
- utility function (consumption and leisure),
- *habit formation* for smoother consumption; Abel (1990), Fuhrer (2000).
- distinguish between Ricardians and non-Ricardian households

Optimization:

Intertemporal

$$\max_{\{C_t^R, A_t, A_t^*, N_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^R - H_t^c)^{1-\psi_c}}{1-\psi_c} - \frac{(N_t^R - H_t^n)^{1+\psi_n}}{1+\psi_n} \right], \quad \max_{\{C_t^{NR}, N_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^{NR})^{1-\psi_c}}{1-\psi_c} - \frac{(N_t^{NR})^{1+\psi_n}}{1+\psi_n} \right]$$

$$A_t + S_t A_t^* + (1+\tau_t^c) P_t C_t^R = (1+i_{t-1}) A_{t-1} + (1+i_{t-1}^* + \zeta_{t-1}^*) S_t A_{t-1}^* + \\ + (1-\tau_t^w + \tau_t^b) W_t N_t^R + (1-\tau^f) \Pi_t,$$

$$(1+\tau_t^c) P_t C_t^{NR} = (1-\tau_t^w + \tau_t^b) W_t N_t^{NR},$$

Intratemporal

$$\min_{C_t^d, C_t^m} P_t C_t = P_t^d C_t^d + P_t^m C_t^m.$$

Firms: retailers, producers, importers

Specification:

- rigidities: labour and prices,
- part of producers re-set prices; Calvo (1983), Gali and Gertler (1999),
- prices of imports are given (assumption of a small economy; "price taker").

Optimization:

- maximization of profit function with regard to production function.

Retailers

$$\min_{Q_{jt}} \quad P_t^d Q_t = \int_0^1 P_{jt}^d Q_{jt} \mathrm{d}j, \qquad Q_t = \left[\int_0^1 (Q_{jt})^{\theta_q} \, \mathrm{d}j \right]^{\frac{1}{\theta_q}}.$$

Producers

$$\max_{\{P_{jt}^d, L_{jt}, M_{jt}\}} \quad \Pi_{jt}^d = E_0 \sum_{t=0}^{\infty} \beta^t (P_{jt}^d - MC_t^d) Q_{jt}, \qquad Q_{jt} = Z_t L_{jt}^{\alpha} M_{jt}^{1-\alpha} - \Upsilon_t^l L_{jt} - \Upsilon_t^m M_{jt}.$$

Importers

$$\max_{\{P_{jt}^m\}} \quad \Pi_{jt}^m = E_0 \sum_{t=0}^{\infty} \beta^t (P_{jt}^m - MC_t^m) C_{jt}^m, \qquad C_{jt}^m = C_t^m \left(\frac{P_{jt}^m}{P_t^m} \right)^{-\sigma_m}.$$

Labour market

Specification:

- only a part of employees negotiate their wage; Erceg, Henderson and Levin (1999).

$$W_t = \left[(1-\xi_w)(\tilde{W}_t)^{1-\sigma_l} + \xi_w (W_{t-1})^{1-\sigma_l}\right]^{\frac{1}{1-\sigma_l}}.$$

Optimization:

- maximization of utility function with regard to wage and labour demand function.

$$\tilde{W}_{it} = \left(\frac{\theta_l}{1-\theta_l}\right) \left[\frac{E_t \sum_{j=0}^{\infty} (\beta\xi_w)^j U_{nt+j} N_{it+1}}{E_t \sum_{j=0}^{\infty} (\beta\xi_w)^j U_{ct+j} \left(\frac{1-\tau_w+\tau_b}{1+\tau_c}\right) \frac{N_{it+j}}{P_{t+j}}}\right].$$

Monetary policy

- Inflation targeting regime,
- interest rates are set according to Taylor rule with regard to smoothing of interest rate. Taylor (1993), Svensson (1998).

$$i_t = (1 - \phi_i)[\bar{i} + \lambda_\pi \hat{\pi}_t + \lambda_y \hat{y}_t] + \phi_i i_{t-1}.$$

Fiscal policy

- Aggregated revenues and expenditure,

$$GR_t = PIT_t + CIT_t + VAT_t + EXCISE_t = \tau_t^w W_t L_t + \tau^f \Pi_t + \tau_t^c P_t C_t,$$

$$GE_t = G_t + G_t^s = G_t + \tau_t^b W_t N_t,$$

- focus on deficit and debt development.

$$D_t = GE_t - GR_t, \qquad B_t = D_t + (1 + i_{t-1}) B_{t-1}.$$

Fiscal rule

Two important issues:

- reference value that runs fiscal rule (debt or deficit?);
- adjusted budgetary item (on revenue or expenditure side?).

$$\frac{G_t}{P_t} = (1 - \phi_g) \frac{\bar{G}_{t-1}}{P_{t-1}} + \phi_g \frac{G_{t-1}}{P_{t-1}}.$$

Implicit tax rates

- Tax rate on consumption (value added tax and excise tax) τ_t^c, rate of benefits to households τ_t^b and personal income tax rate τ_t^w.
- Tax rates are decomposed for modelling purposes as

$$\tau_t^x = \bar{\tau}^x + \hat{\tau}_t^x,$$

$$\bar{\tau}^c = \frac{T_t^c}{P_t C_t} = \frac{VAT_t + EXCISE_t}{P_t C_t}, \qquad \bar{\tau}^w = \frac{T_t^w}{W_t L_t}, \qquad \bar{\tau}^b = \frac{G_t^s}{W_t N_t}.$$

World

- Approximation of external environment by small structural model of the EA (simple version of Smets & Wouters (2002)):

$$\hat{y}_t^* = \omega_{yy}^* \hat{y}_{t-1}^* + (1-\omega_{yy}^*) E_t(\hat{y}_{t+1}^*) - \omega_{yi}^* E_t(\hat{i}_t^* - \hat{\pi}_{t+1}^*) + u_t^{y*},$$

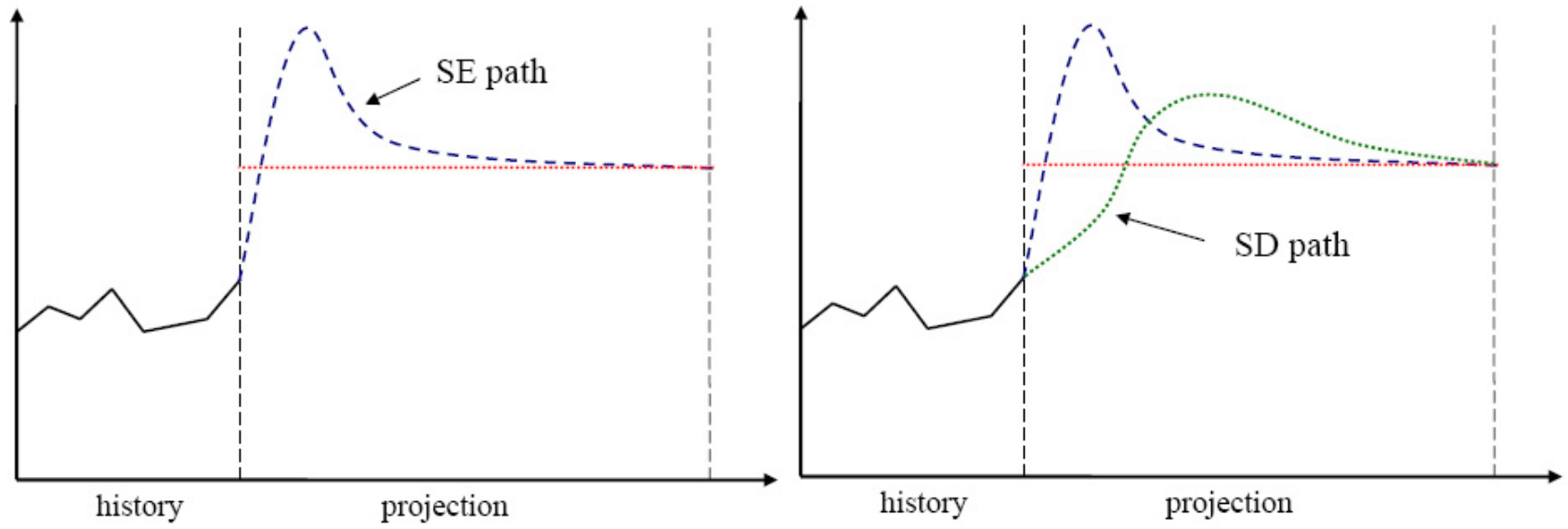
$$\hat{\pi}_t^* = \omega_{pp}^* \hat{\pi}_{t-1}^* + (1-\omega_{pp}^*) E_t(\hat{\pi}_{t+1}^*) + \omega_{pc}^* \hat{y}_t^* + u_t^{p*},$$

$$\hat{i}_t^* = \omega_{i\pi}^* \hat{\pi}_t^* + \omega_{iy}^* \hat{y}_t^* + \omega_{ii}^* \hat{i}_{t-1}^* + u_t^{i*}.$$

Solution of the model

1. **Steady state of the model (SS)** - trend component of variables; constant growth rates for non-stationary variables, constants for stationary variables (average levels);
2. **Short-run equilibrium, (SE) - simulations** - i.e. trajectory from current state to equilibrium:
   - derivation of the model - theoretical assumptions, conditions and model dynamics (expressed in equation system),
   - solution of the nonlinear equation system → using **log-linearization**:
     – variables expressed in logarithms,
     – aproximation by first order Taylor expansion around steady state,
     → linearized equations with variables expressed in terms of logarithmic deviations from steady state,
   - for final solution of equation system we need to set values of parameters in equations (elasticities, weights,..)→ **calibration of the model**,
   - result of these two steps - linearized equation system with both, forward looking and lagged variables.

3. **Short-run dynamics, (SD) - predictions** - combination of an ad-hoc specifications of respective variables and SE trajectory → forecast of a variable.



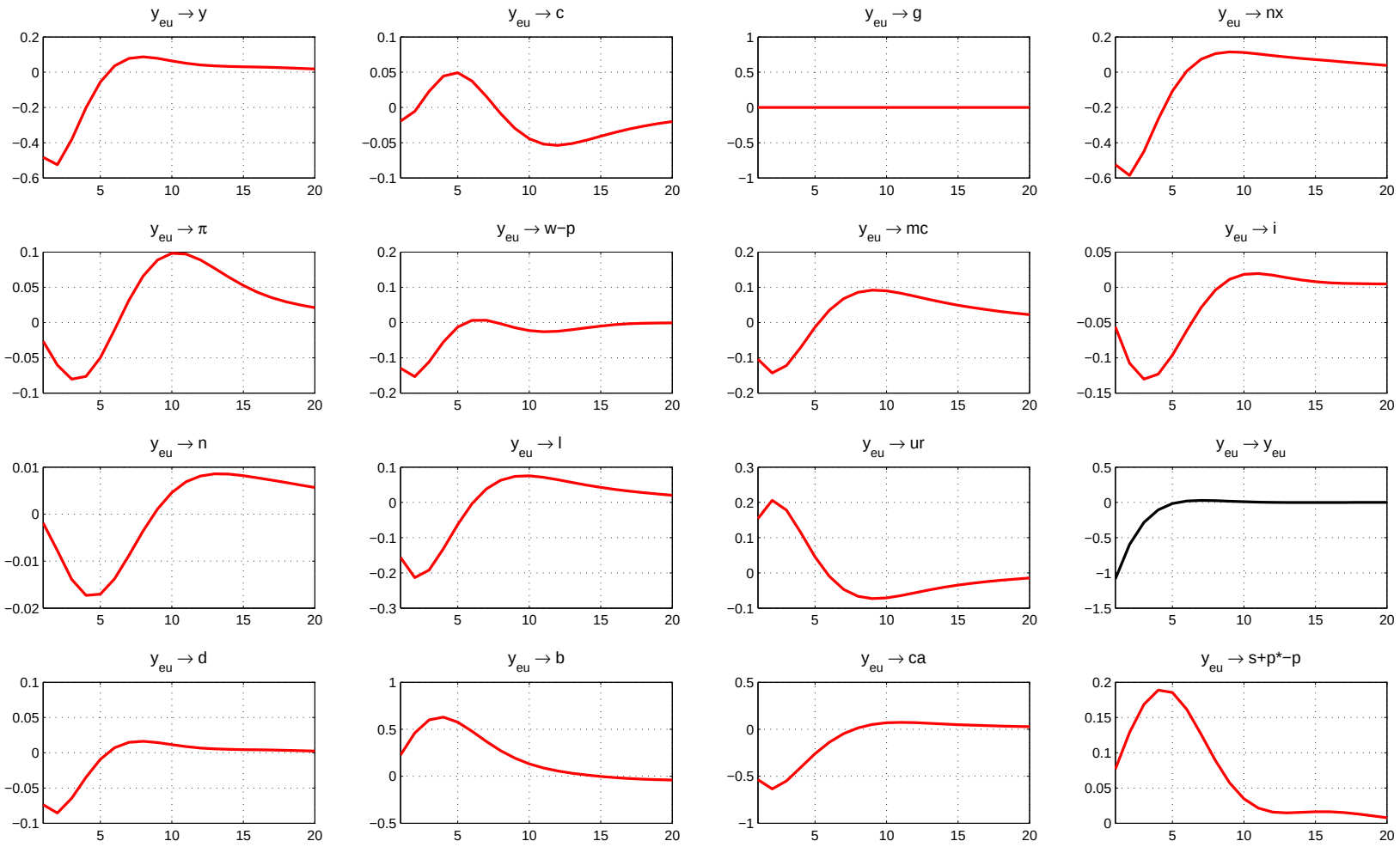
Source: **Harrison et al.:** The Bank of England Quarterly Model, *Bank of England, 2005.*

Simulation results - Slower EU GDP growth and higher domestic interest rate

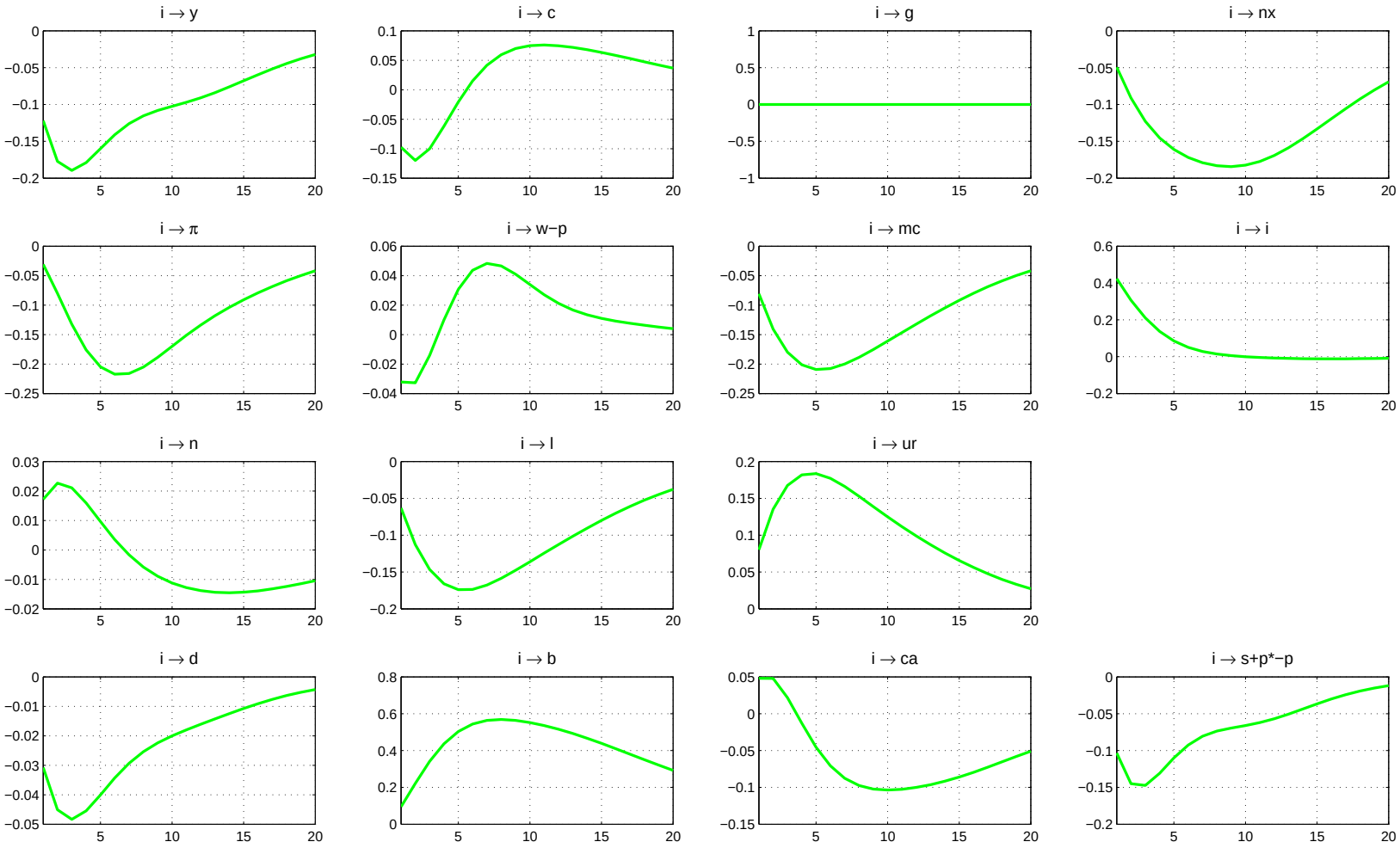
- Effect of the EU GDP slowdown by 1 p.p. in 2012
- Effect of the increase in domestic interest rate by 0.5 p.p. in 2012

Variable	shock in i	shock in y_{eu}
GDP	-0.3	-0.7
consumption	-0.2	0.0
net inflation	-0.2	-0.1
unemployment rate	0.2	0.3

Simulation results - EU GDP growth



Simulation results - interest rate



Conclusion...

- Simple, quite standard, manageable model,
- allows to estimate impact of some fiscal measures or foreign development,
- will be extended.

...and next steps

- Capital and price of capital,
- search and matching model of the labor market (Pissarides) ,
- distinguish between tradable and non-tradable sector.

Thank you for your attention.

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