Seminar to Advanced Macroeconomics

Contemporary Empirical Macroeconomic Models: An Introduction

Motivation

- Real business cycles: technology shocks, economy always in optimum.
- The need for more complicated and more realistic models:

1. More shocks explicitly included in the model explicitely: monetary, fiscal, preferences, supply
2. Rigidities – rigid prices and wages, slower adjustment; temporary deviations from optimal path allowed
3. Inclusion of monetary sector – prices and interest rates that are important for monetary policy setting.

- Aim of such models: forecast economic activity, estimate effects of policy changes under various settings; most of the research is focused on analysis of monetary policy.

Outline

- Current macro models: pre-crisis consesus
- VAR's
- Structural models: DSGE

  = Dynamic Stochastic General Equilibrium Models
- A simple New Keynesian DSGE model
- Evaluation of different DSGE models

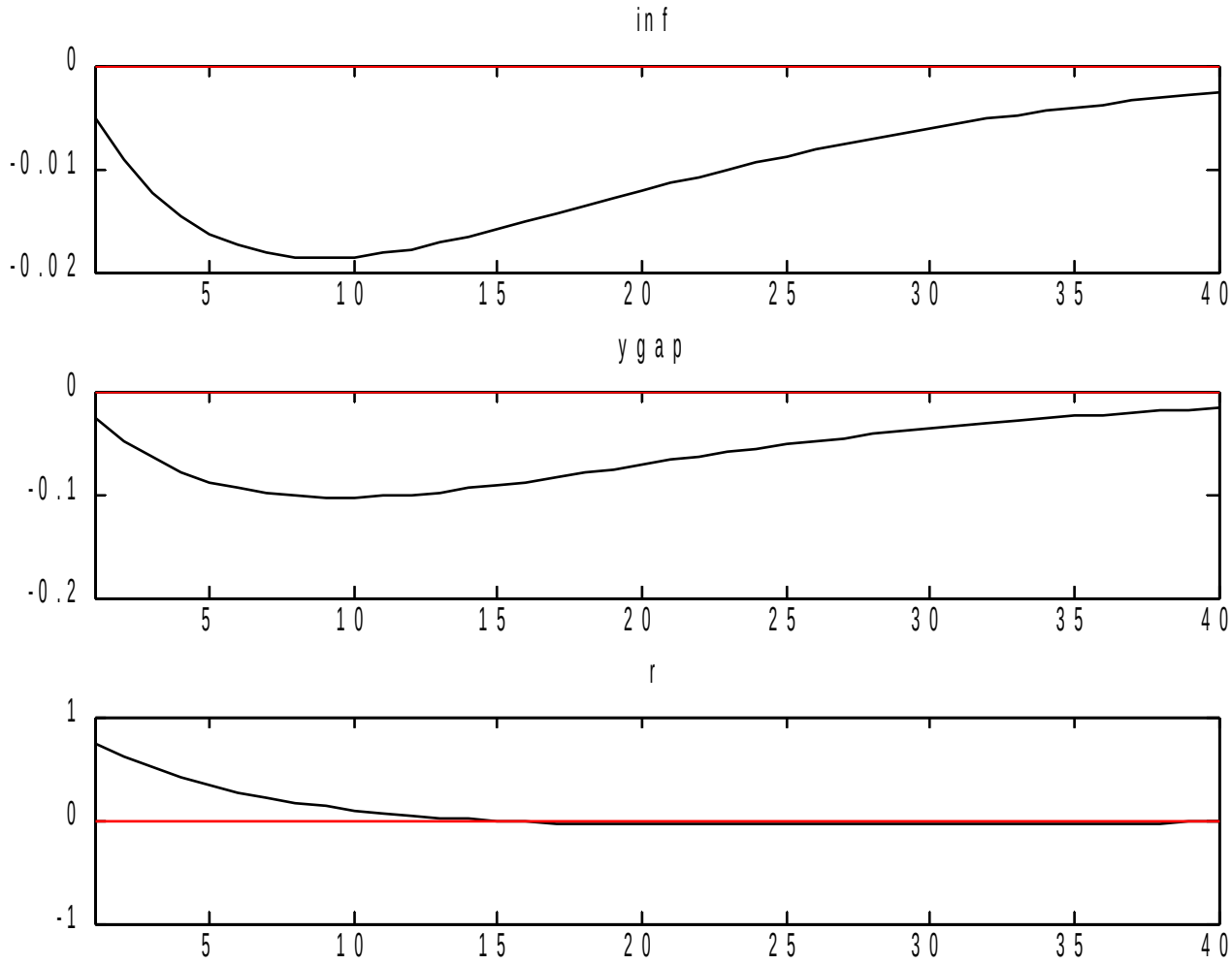
Pre-crisis consensus on the general framework of macroeconomic analysis

- 1990's and 2000's: convergence among academics and researchers on a general framework for conducting analysis mainly monetary policy, but such a convergence was quite broad.
- Convergnce was more in terms of method than the explicit model: the methodology was/is rather flexible to accomodate divergent views regarding the „How the economy works“ problem.
- David Colander in Journal of History of Economic Thought (2000) calls this consensus as „The New Millenium Economics“.

Pre-crisis consensus on the general framework of macroeconomic analysis

- Key building blocks of the methodology
- **Quantitative macro model**, that is *structural* (invariant to policy changes and consistent with both theory and data).
- **Stochastic simulations** are used to determine functioning of main variables. Usually by estimating *impulse responses*.
- **Rational expectations** and **intertemporal optimization** used much more comparing to earlier periods.
- Alternatively, **vector autoregressions** (VAR) applied to empirical problems and forecasting.
- Next slide: example of estimated impulse responses: dynamic effects of a change in interest rate to other variables (output gap and inflation)

Effects of monetary policy shock



VAR's and structural models

- **Vector autoregression** (VAR) applied to empirical problems and forecasting.

$$y_t = \Phi_1 y_{-1} + ... + \Phi_p y_{t-p} + \varepsilon_t$$

$$y_{1t} = b_1 + \sum_{i=1}^{p} \gamma_{11}^{i} y_{1,t-i} + \sum_{i=1}^{p} \gamma_{12}^{i} y_{2,t-i} + \varepsilon_{1t}$$

$$y_{2t} = b_2 + \sum_{i=1}^{p} \gamma_{21}^{i} y_{1,t-i} + \sum_{i=1}^{p} \gamma_{22}^{i} y_{2,t-i} + \varepsilon_{2t}$$

- In fact a multivariate AR model.
- Example of **structural model:**

$$y_t = b_0 + b_1 (R_t - E_t \Delta p_{t+1}) + E_t y_{t+1} + v_t$$
$$\Delta p_t = \beta E_t \Delta p_{t+1} + \alpha (y_t - \bar{y}_t) + u_t$$
$$R_t = (1-\mu_3)[r + \Delta p_t + \mu_1 (\Delta p_t - \bar{\pi}) + \mu_2 (y_t - \bar{y}_t)] + \mu_3 R_{t-1} + e_t$$

- Set of equations with lagged and forward looking variables, different shocks and parameters, that can be either estimated or calibrated.

VAR's and structural models

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$$y_t = \Phi_1 y_{-1} + \ldots + \Phi_p y_{t-p} + \varepsilon_t$$

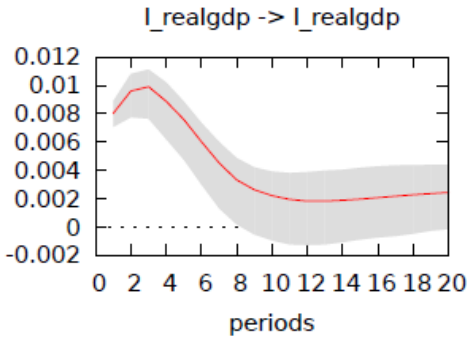
- Common properties
- The economy tends to a long term equilibrium; shocks have temporary effects and do not cause shifts or other permanent changes.
- Multiple shocks and all can have different quantitative and qualitative effects
- Basic diagnostic tool: impulse response function („what happens with output gap if an increase in interest rate occur?“)

Vector Autoregression

- Exampe of vector autoregression: VAR 1 on GDPgap, inflation, interest rate and unemployment:

$$\Delta y_t = a_0 + a_1 \Delta y_{t-1} + a_2 \pi_{t-1} a_3 r_{t-1} + a_4 u_{t-1} + \varepsilon_y$$
$$\pi_t = b_0 + b_1 \Delta y_{t-1} + b_2 \pi_{t-1} + b_3 r_{t-1} + b_4 u_{t-1} + \varepsilon_\pi$$
$$r_t = c_0 + c_1 \Delta y_{t-1} + c_2 \pi_{t-1} + c_3 r_{t-1} + c_4 u_{t-1} + \varepsilon_r$$
$$u_t = d_0 + d_1 \Delta y_{t-1} + d_2 \pi_{t-1} + d_3 r_{t-1} + d_4 u_{t-1} + \varepsilon_u$$

Next slide: impulse responses of this model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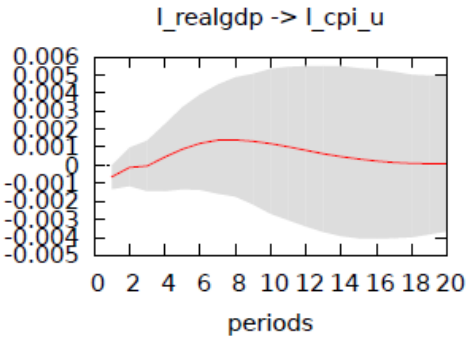
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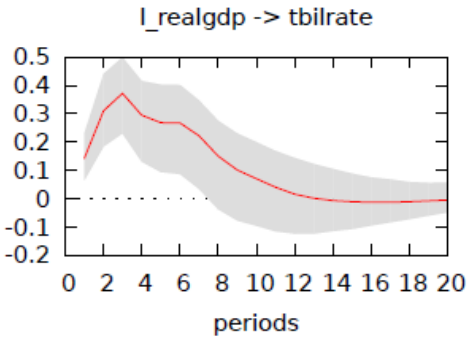
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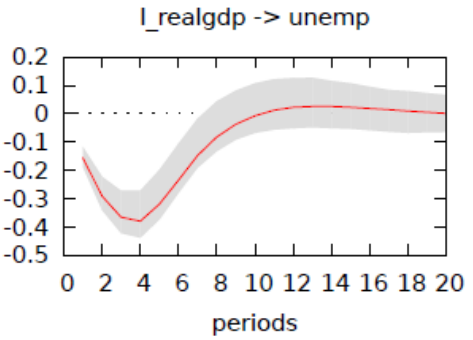
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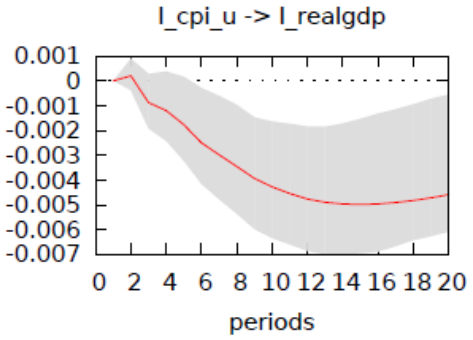
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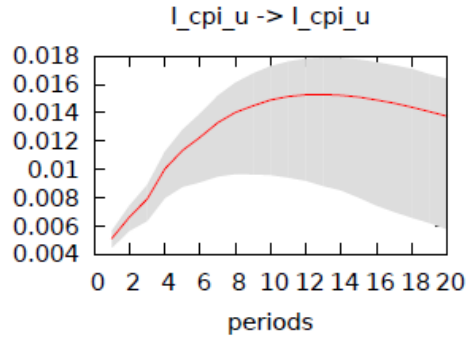
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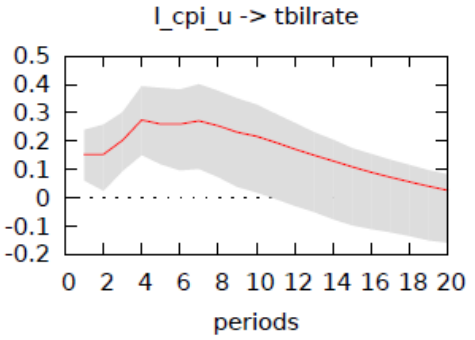
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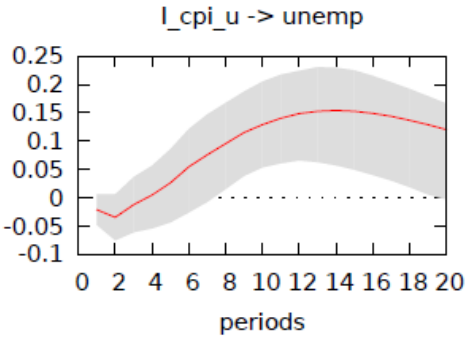
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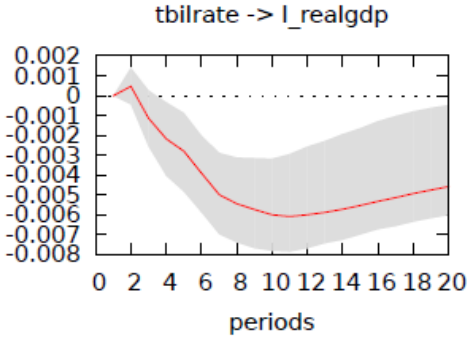
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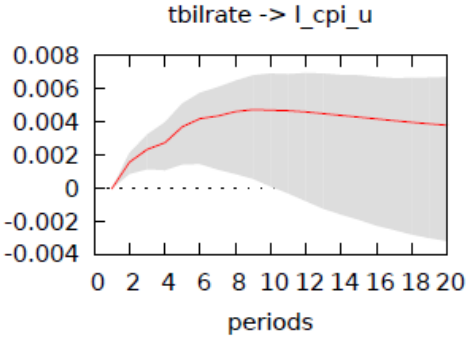
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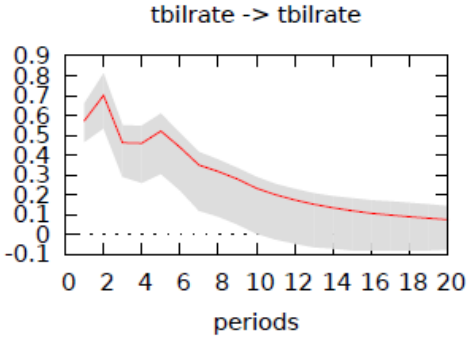
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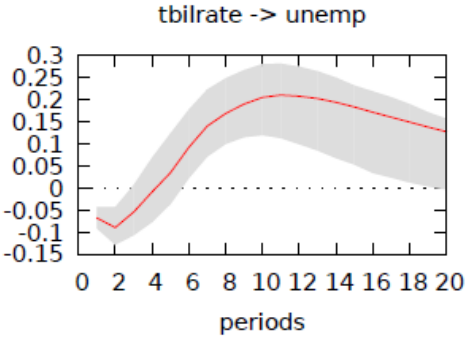
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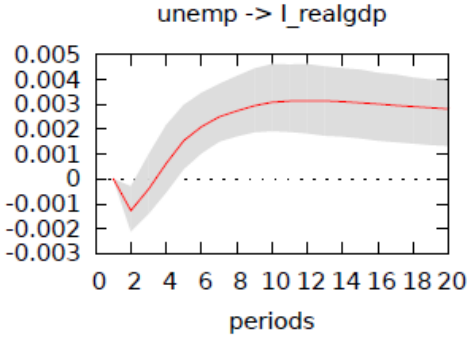
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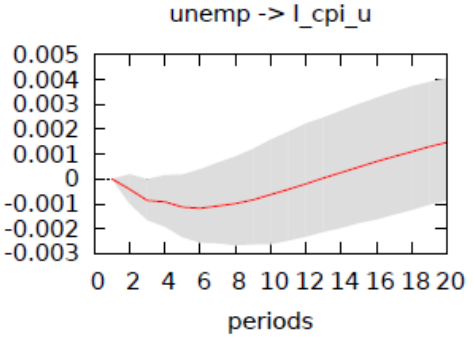
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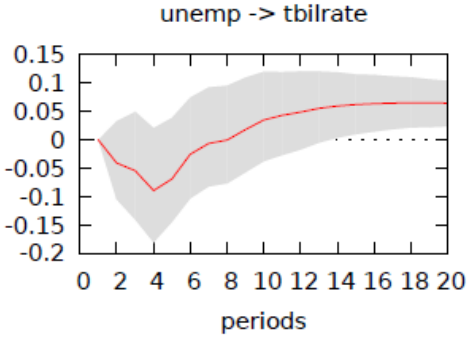
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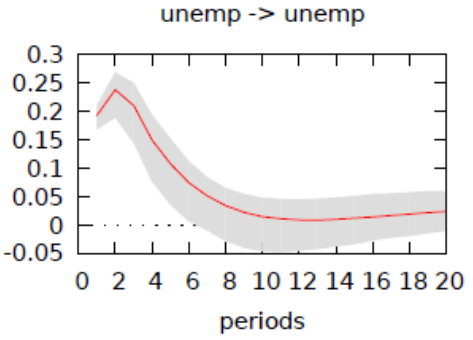
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Vector Autoregression

- VAR's: unconditional on theory
    - Actually there is a little bit of theory: in ordering, scaling and choice of the variables, sometimes there are some additional restrictions regarding causality; but this can be let for other classes.
- DSGE: structural models (invariant to policy changes)
- Results: IR's and forecasts, too.

A Simple DSGE Model

- Structural model (= invariant to policy changes) that is consistent with both theory and data too.
- 3-equations model: IS curve, Philips curve, Taylor rule
- Demand side, supply side and monetary sector

$$y_t = b_0 + b_1(R_t - E_t \Delta p_{t+1}) + E_t y_{t+1} + v_t$$

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- Again some related notions: Lucas' critique, rational expectations

Note: Taylor Rule

- Monetary policy is the process by which the monetary authority of a country controls … in order to attain a set of objectives oriented towards the growth and stability of the economy.
- The most important objective: stable and low inflation
- If more objectives? => Some policy mix necessary
- Description of the behavior of central bank suitable for quantitative analysis and forecasting: The **Taylor Rule**:
- Formally: $i_t = \pi_t + \bar{r}_t + a_\pi(\pi_t - \bar{\pi}_t) + a_y(y_t - \bar{y}_t)$
- How much the central bank should change the nominal interest rate in response to divergences of actual GDP from potential GDP and of actual inflation rates from a target inflation rates. (John B. Taylor, 1993).

A Simple DSGE Model

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- y_t, p_t: logs of gdp and price level, "y_t bar": potential output
- $E_t x_{t+1}$...expectations of value of variable x at t+1 in time t
- v_t,u_t,e_t are exogeneous shocks – v_t: fiscal policy and demand tastes, that is shock into AD, u_t: supply shock, e_t: monetary policy shock

A Simple DSGE Model

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- Coefficients estimated or calibrated
- Structure of shocks: AR(1) with given persistence parameter and variance

A Simple DSGE Model

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- The model is then linearized around its steady state (similarly to RBC or the Ramsey model) and then simulations for sequence of shocks are performed (in very similar way to your problem set)
- Simulated series facing to sequence of shocks: moments
- Simulated series facing one time shock: Impulse responses

A Simple DSGE Model

$$y_t = b_0 + b_1(R_t - E_t \Delta p_{t+1}) + E_t + y_{t+1} + v_t$$

$$\Delta p_t = \beta E_t \Delta p_{t+1} + \alpha(y_t - \bar{y}_t) + u_t$$

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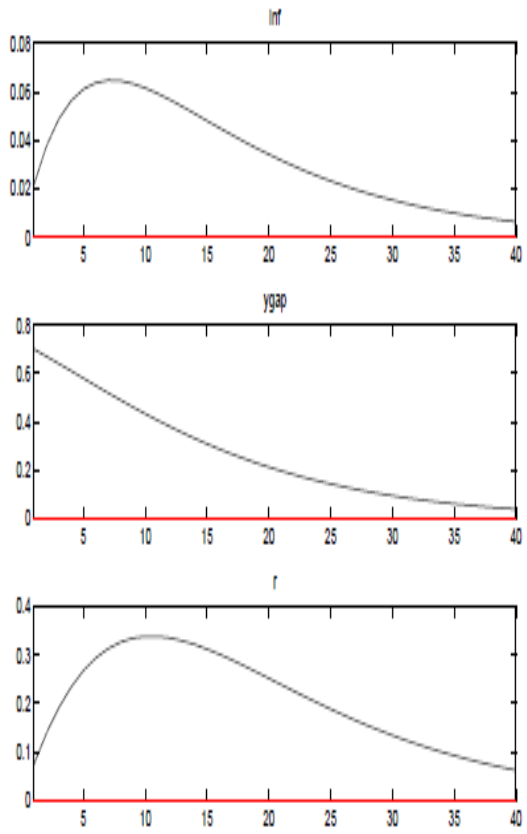

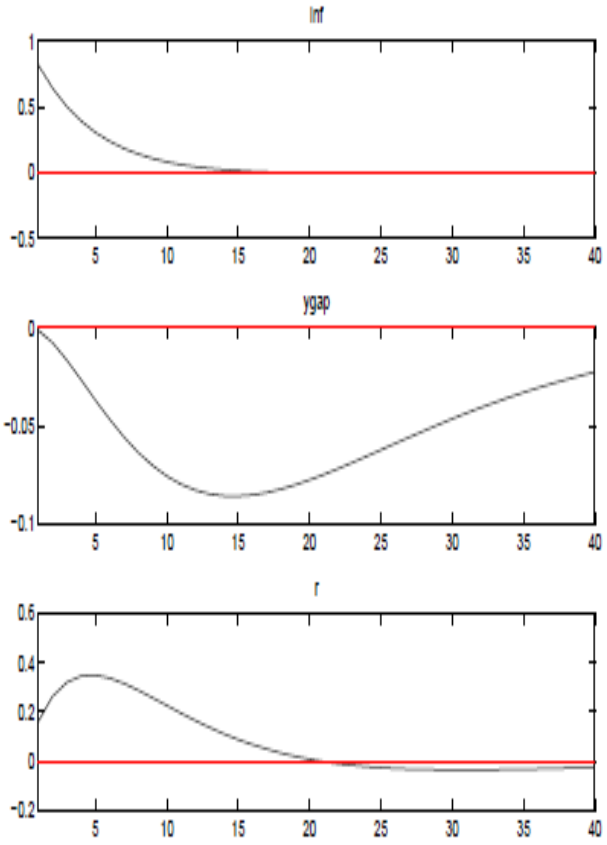

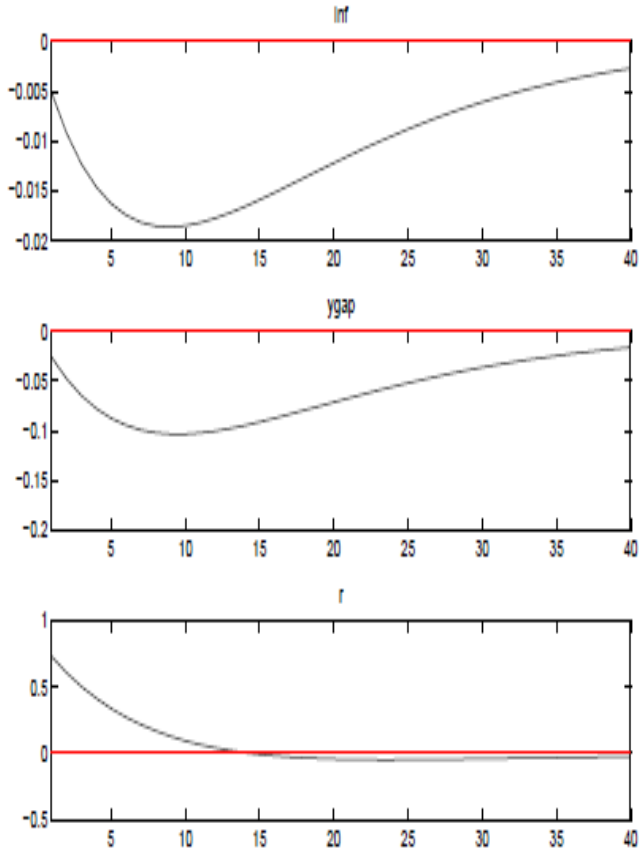

A Simple DSGE Model

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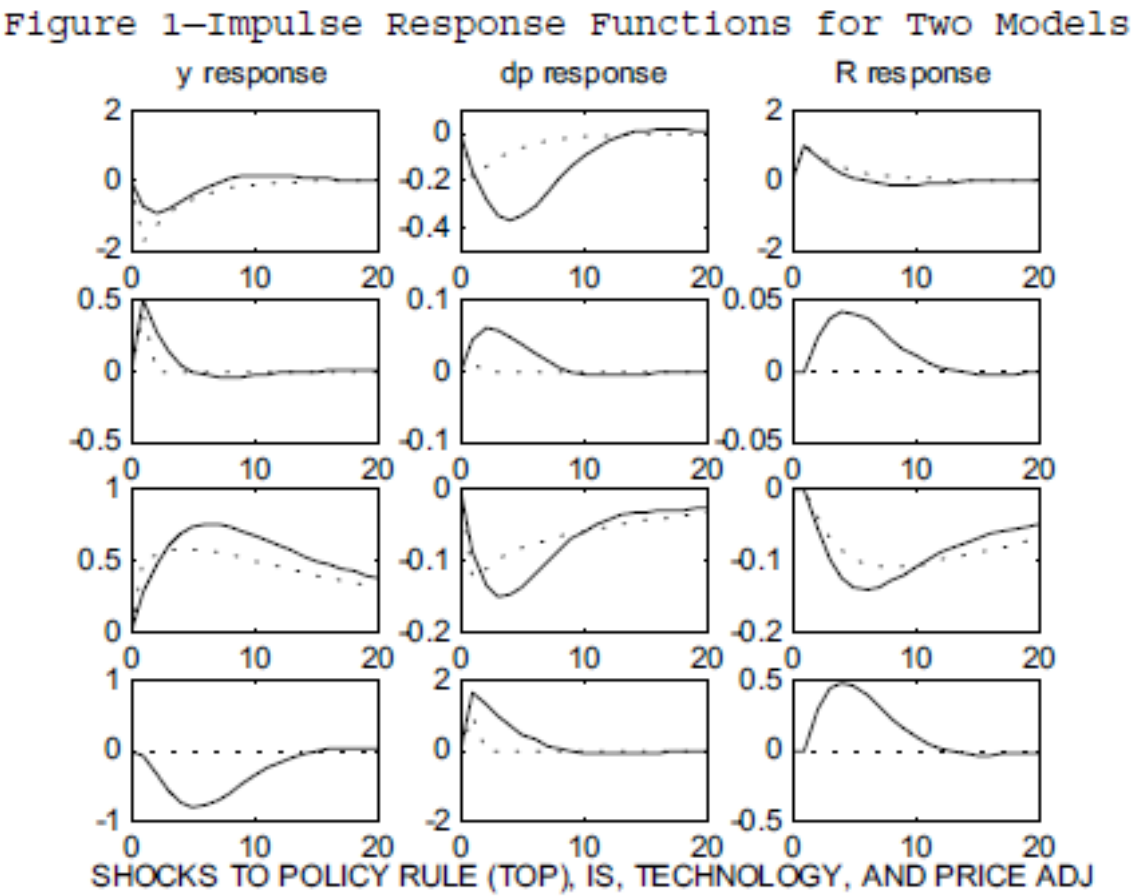
- Properties of the results are determined by:
- Values of parameters and structure of shocks
- Theoretical assumptions: adaptive expectations, persistence in consumption habits and willingness to smooth the interest rate might change the outcomes keeping values of parameters untouched...

A Simple DSGE Model



Summary

- The monetary policy affects the real economy using various tools.
- The behavior of the central bank can be described by the Taylor rule
- The effects of the transmission monetary policy can be measured using the impulse response functions.
- These can be obtained from VARs or DSGE models.
- The difference: VARs atheoretical, DSGE structural, unlike RBC contain many shocks, rigidities and monetary transmission

Key points

- How the monetary policy affects the real economy
- Taylor rule and the objectives of central banks
- VAR (vector autoregression)
- DSGE (dynamic stochastic general equilibrium)
- Interpretation of the impulse responses

Script

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