Monetary Economics

Lecture 12: monetary/fiscal interactions in the new Keynesian model, part two

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This class

- Monetary/fiscal interactions in the new Keynesian model, part two

- The zero lower bound. Implications for multipliers.

- Main reading:

  - Woodford "Simple analytics of the government expenditure multiplier" *AEJ: Macroeconomics*, 2011

- Further reading

  - Christiano, Eichenbaum and Rebelo "When is the government spending multiplier large?" *Journal of Political Economy*, 2011

Available from the LMS

This class

1- Intuition from simple two-state example

- exogenous interest rate spread
- ZLB binds in a crisis if fiscal stimulus insufficient
- multiplier larger than one if ZLB binds

2- Results from estimated DSGE model

New Keynesian model from last class

- Dynamic IS curve

$$\tilde{y}_t = -\frac{1}{\sigma}(i_t - \mathbb{E}_t[\pi_{t+1}] - r_t^n) + \mathbb{E}_t[\tilde{y}_{t+1}]$$

- New Keynesian Phillips curve

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa \tilde{y}_t$$

- Interest rate rule

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \tilde{y}_t$$

- Natural rate and natural output

$$r_t^n = \rho - \sigma(1-\Gamma)\mathbb{E}_t[\Delta \hat{g}_{t+1}], \qquad y_t^n = \Gamma \hat{g}_t$$

ZLB extension

- Suppose interest rate facing household is not i_t but

$$i_t + \Delta_t$$

where *spread* $\Delta_t \geq 0$ follows an exogenous process

- ZLB on policy interest rate

$$i_t = \max[0, \; \rho + \phi_\pi \pi_t + \phi_y \tilde{y}_t]$$

Two-state example

- Suppose spread Δ_t can take two values $\{\Delta_H, \Delta_L\}$ with transition probabilities

$$\text{Prob}[\Delta_{t+1} = \Delta_L \,|\, \Delta_t = \Delta_L] = \alpha$$
$$\text{Prob}[\Delta_{t+1} = \Delta_H \,|\, \Delta_t = \Delta_L] = 1 - \alpha$$
$$\text{Prob}[\Delta_{t+1} = \Delta_H \,|\, \Delta_t = \Delta_H] = 1$$

(hence Δ_H is an *absorbing state*)

- Endogenous variables a function of state: $\{\pi_H, \pi_L, \tilde{y}_H, \tilde{y}_L, \cdots\}$

- Start the economy in the Δ_L state, random duration T periods until Δ_H state is reached

- Expected *duration* of crisis governed by transition probability α

Two-state example (cont).

- H state is "normal" steady state, so let

$$\Delta_H = 0, \quad \pi_H = 0, \quad \tilde{y}_H = 0, \quad \hat{g}_H = 0, \quad i_H = \rho$$

- L state is "crisis", want to solve for endogenous variables as functions of $\Delta_L > 0$ and fiscal policy $\hat{g}_L > 0$

- Note possibly confusing convention that $\Delta_L > \Delta_H = 0$

Solving the two-state model

- New Keynesian Phillips curve

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa \tilde{y}_t$$

- So starting in the L state

$$\pi_L = \beta[\alpha \pi_L + (1-\alpha)\pi_H] + \kappa \tilde{y}_L$$

$$= \beta[\alpha \pi_L] + \kappa \tilde{y}_L$$

or

$$\pi_L = \frac{\kappa}{1-\alpha\beta}\tilde{y}_L$$

Solving the two-state model (cont).

- Natural rate

$$r_t^n = \rho - \sigma(1-\Gamma)\mathbb{E}_t[\Delta\hat{g}_{t+1}]$$

- Again, starting in the L state

$$r_L^n = \rho - \sigma(1-\Gamma)[\alpha(\hat{g}_L - \hat{g}_L) + (1-\alpha)(\hat{g}_H - \hat{g}_L]$$

$$= \rho + \sigma(1-\Gamma)(1-\alpha)\hat{g}_L$$

Plug this into the dynamic IS curve

Solving the two-state model (cont).

- Dynamic IS curve in the L state can be written

$$\tilde{y}_L = -\frac{1}{\sigma}(i_L + \Delta_L - \alpha\pi_L - r_L^n) + \alpha\tilde{y}_L$$

(substituting out expected inflation and the expected output gap)

- Now let

$$r_L \equiv \rho - \Delta_L$$

- So we can write

$$(1-\alpha)\tilde{y}_L = \frac{1}{\sigma}(r_L - i_L) + \frac{\alpha\kappa}{\sigma(1-\alpha\beta)}\tilde{y}_L + (1-\alpha)(1-\Gamma)\hat{g}_L$$

Solving the two-state model (cont).

- So for a given interest rate i_L the output gap is

$$\tilde{y}_L = \vartheta_r(r_L - i_L) + \vartheta_g \hat{g}_L$$

with coefficients

$$\vartheta_r \equiv \frac{(1-\alpha\beta)}{\sigma(1-\alpha)(1-\alpha\beta) - \alpha\kappa} > 0 \quad \text{[by assumption on } \alpha\text{]}$$

and

$$\vartheta_g \equiv \frac{\sigma(1-\alpha)(1-\alpha\beta)}{\sigma(1-\alpha)(1-\alpha\beta) - \alpha\kappa}(1-\Gamma) > 1-\Gamma > 0$$

- But i_L is endogenous, determined by policy rule

When does the ZLB bind?

- Interest rate i_L satisfies

$$i_L = \max[0,\ \rho + \phi_\pi \pi_L + \phi_y \tilde{y}_L]$$

$$= \max\left[0,\ \rho + \left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right)\tilde{y}_L\right]$$

$$= \max\left[0,\ \rho + \left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right)\left(\vartheta_r(r_L - i_L) + \vartheta_g \hat{g}_L\right)\right]$$

- Depends on fiscal stance $\hat{g}_L$ in the crisis state

No fiscal stimulus

- Suppose no fiscal stimulus in the crisis state, $\hat{g}_L = 0$
- Then ZLB binds whenever

$$\rho + \left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right) \vartheta_r r_L < 0$$

Equivalently, whenever

$$r_L < r_L^* \equiv -\left(\vartheta_r \left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right)\right)^{-1} \rho < 0$$

- Since $r_L \equiv \rho - \Delta_L$, this is the same as requiring that $\Delta_L > \Delta_L^* > 0$
- In short, in the absence of a fiscal stimulus, *a large enough crisis triggers a binding ZLB*

Threshold fiscal stimulus

- Now suppose this condition is satisfied, so in the absence of fiscal stimulus $i_L = 0$

- If so, ZLB is in fact binding for all insufficiently small levels of stimulus, that is ZLB binds for all

$$\hat{g}_L < \hat{g}_L^* \equiv -\frac{\left(\rho + \left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right)\vartheta_r r_L\right)}{\left(\phi_\pi \frac{\kappa}{1-\alpha\beta} + \phi_y\right)\vartheta_g} > 0$$

(the numerator is < 0 because the condition $r_L < r_L^*$ is satisfied)

Threshold fiscal stimulus

- For any stimulus below the threshold $\hat{g}_L^*$ we have $i_L = 0$ and

$$\tilde{y}_L = \vartheta_r r_L + \vartheta_g \hat{g}_L < 0$$

(with $r_L = \rho - \Delta_L$) and

$$\pi_L = \frac{\kappa}{1 - \alpha\beta}\tilde{y}_L < 0$$

- Multiplier is

$$\frac{dy_L}{d\hat{g}_L} = \frac{d\tilde{y}_L}{d\hat{g}_L} + \frac{dy_L^n}{d\hat{g}_L} = \vartheta_g + \Gamma > 1$$

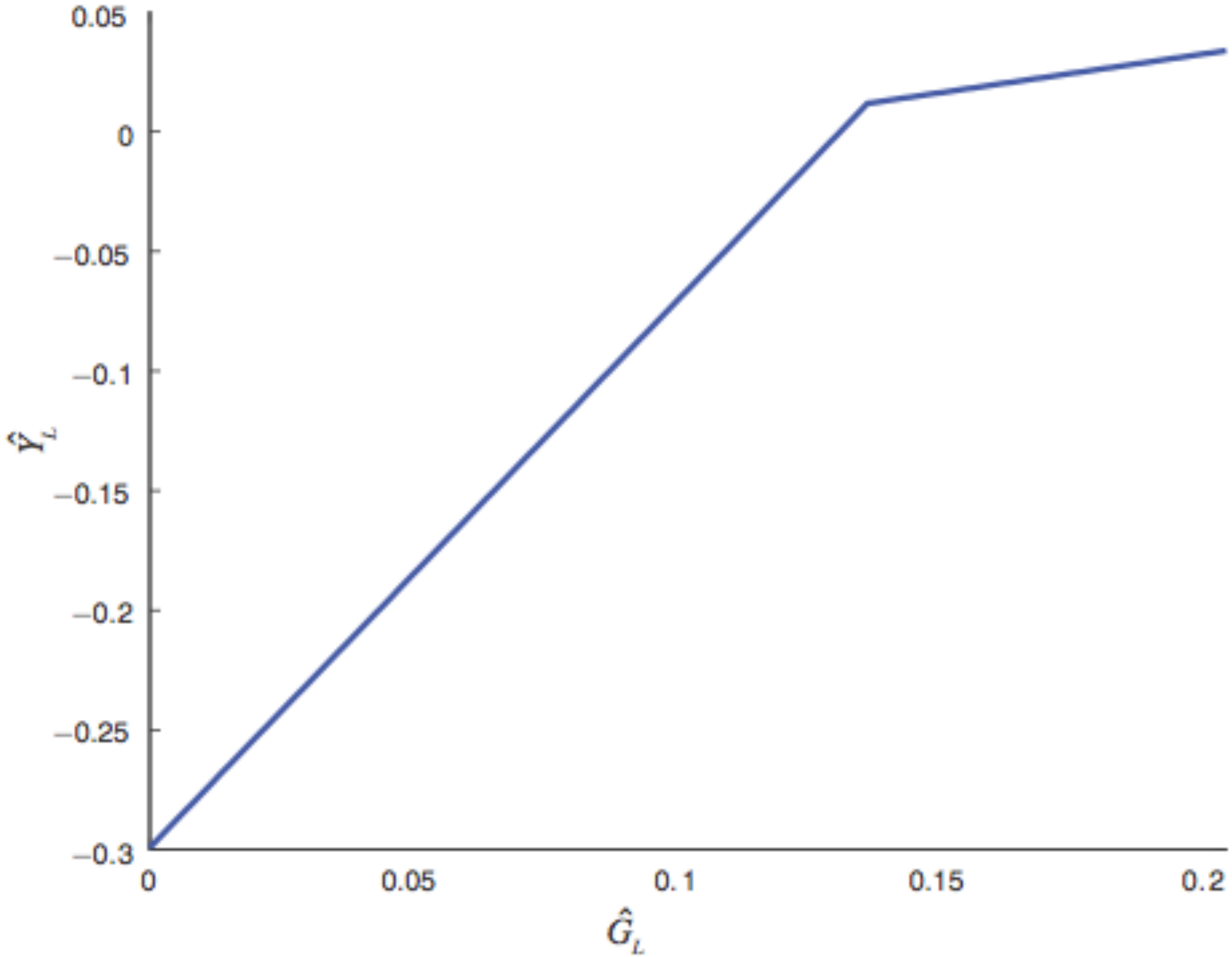
and similarly

$$\frac{d\pi_L}{d\hat{g}_L} > 0$$

- Small changes in $\hat{g}_L$ leave $i_L = 0$. But a large enough change will cross the threshold so that ZLB no longer binds

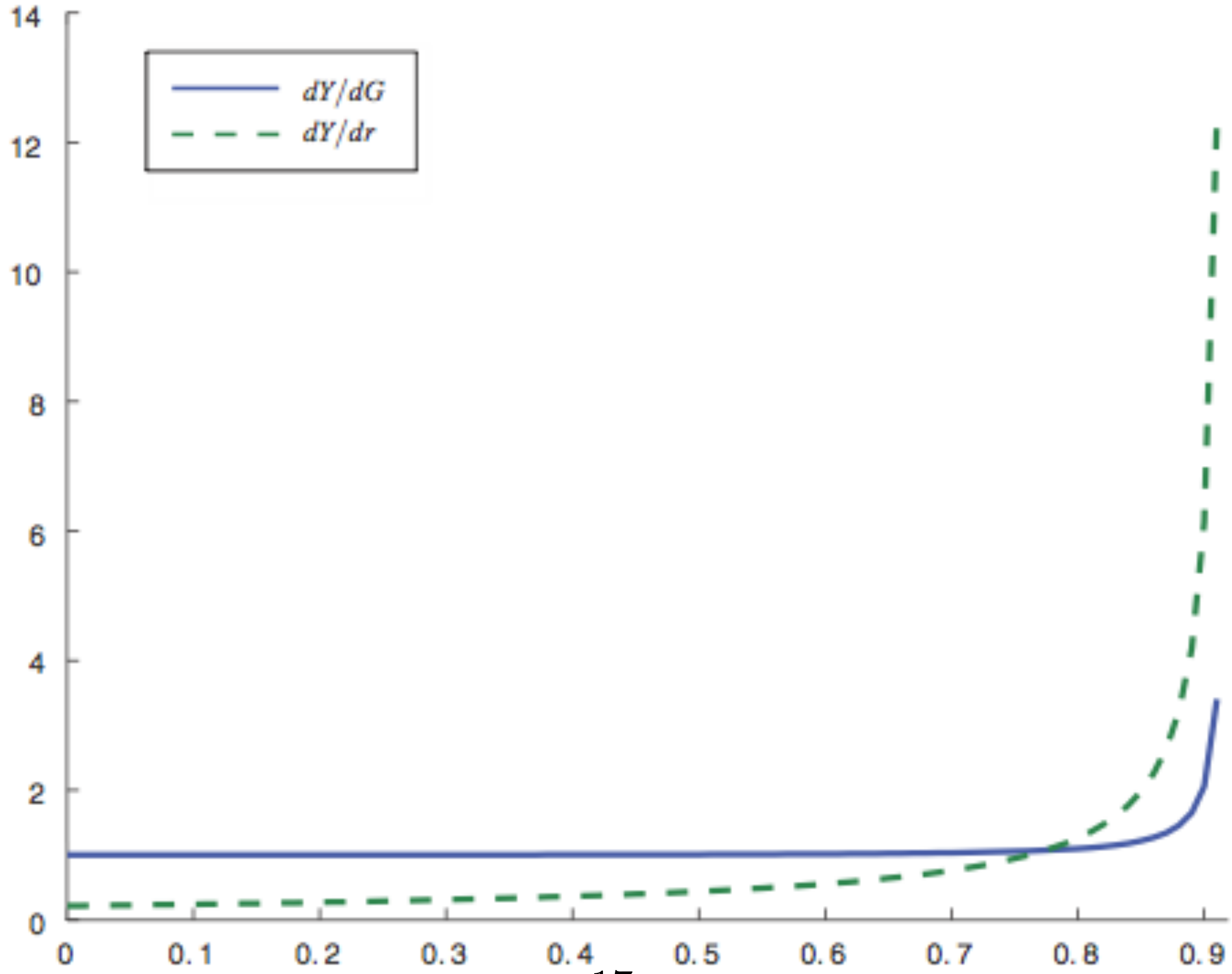
Output as function of government purchases

Below the critical threshold, multiplier is larger than one



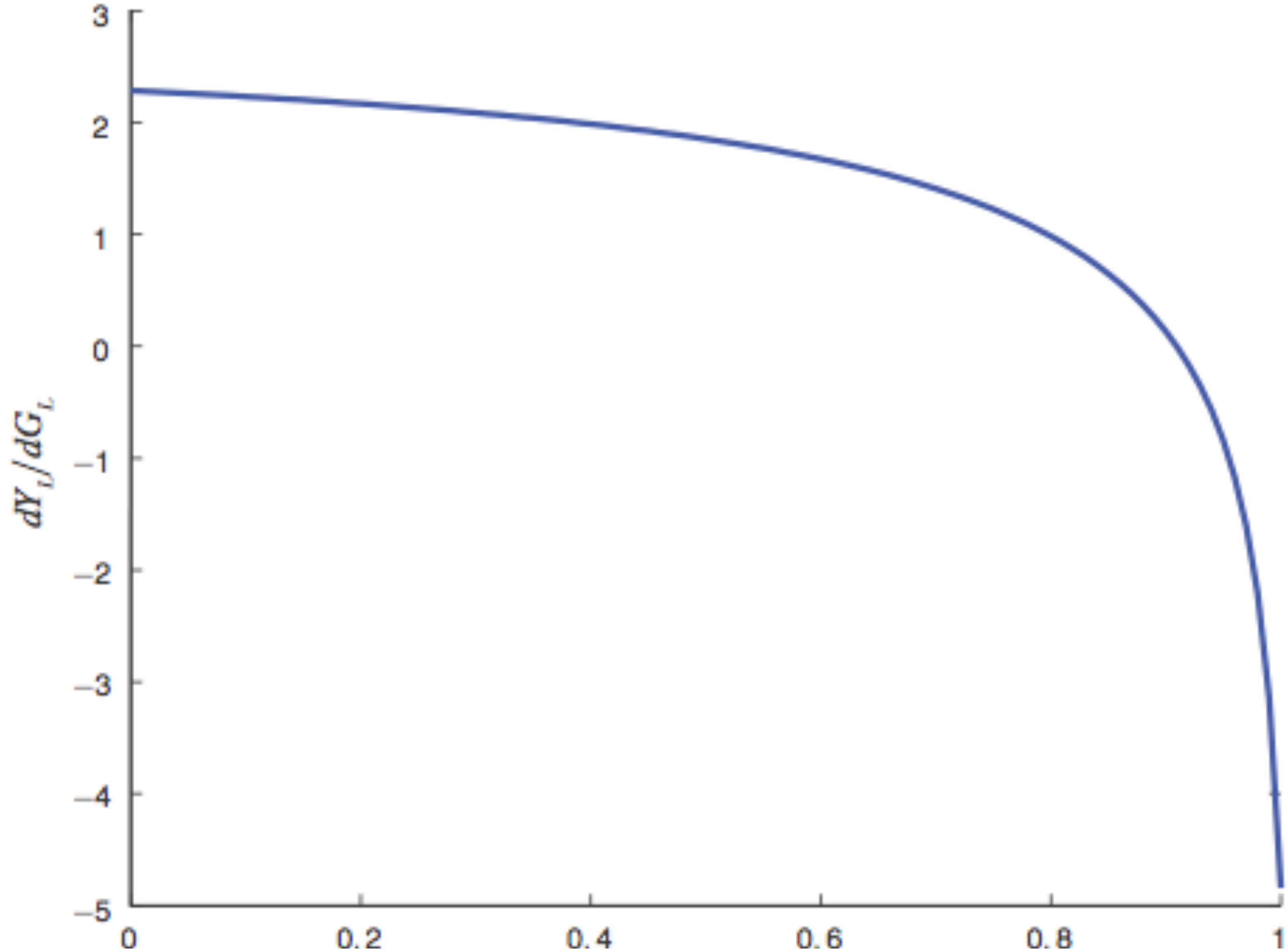
Sensitivities ϑ_g, ϑ_r to probability α

Multiplier large when α high, exactly when low r_L has big consequences



Importance of fiscal stimulus duration

Multiplier as function of probability stimulus continues *after* crisis

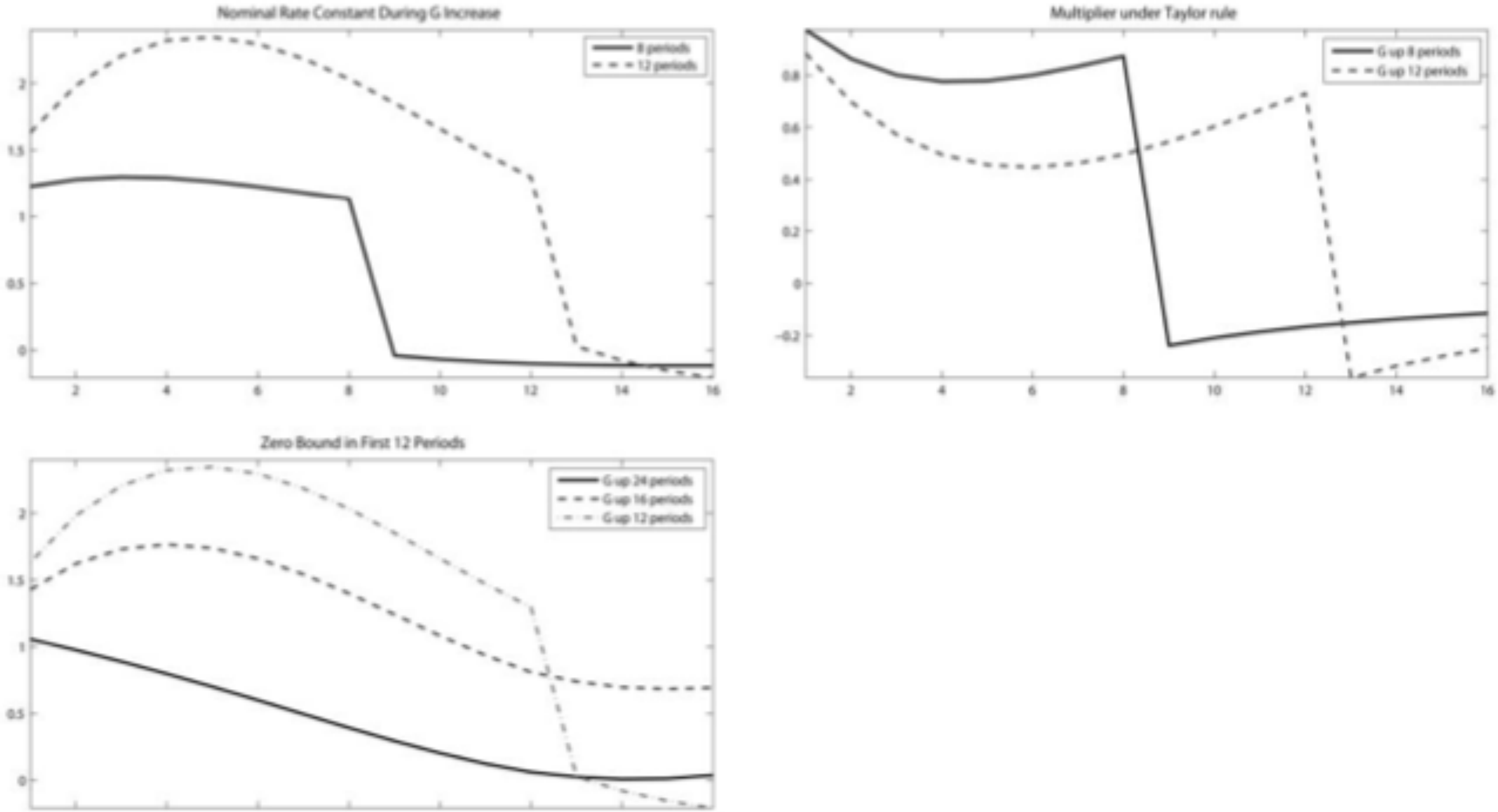


Estimated DSGE model

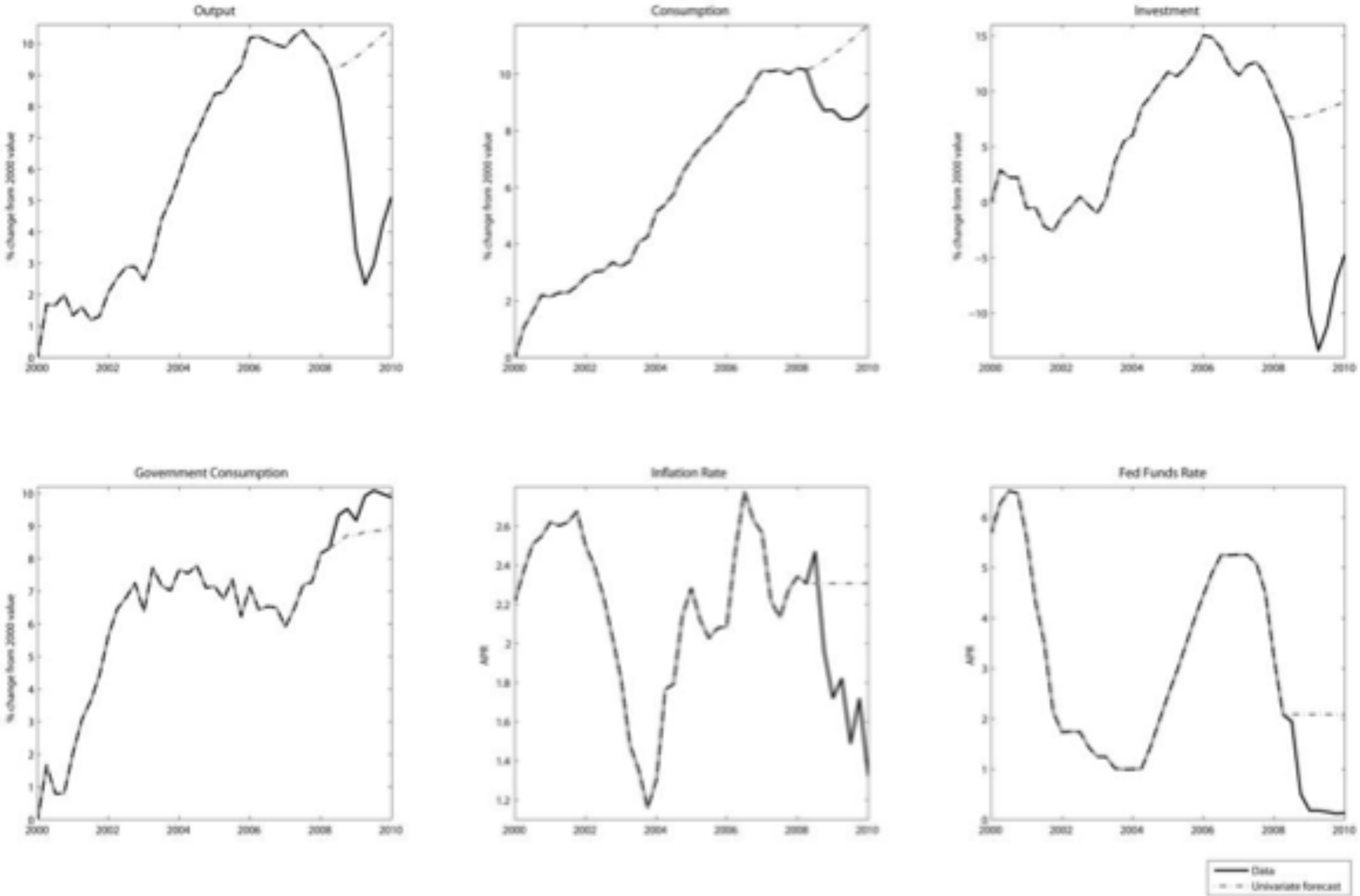
- Similar results from "medium scale" estimated DSGE model with many more bells and whistles
  - investment, capital adjustment costs, variable capacity utilization, habit formation, sticky wages, etc etc

Multiplier in the estimated DSGE model

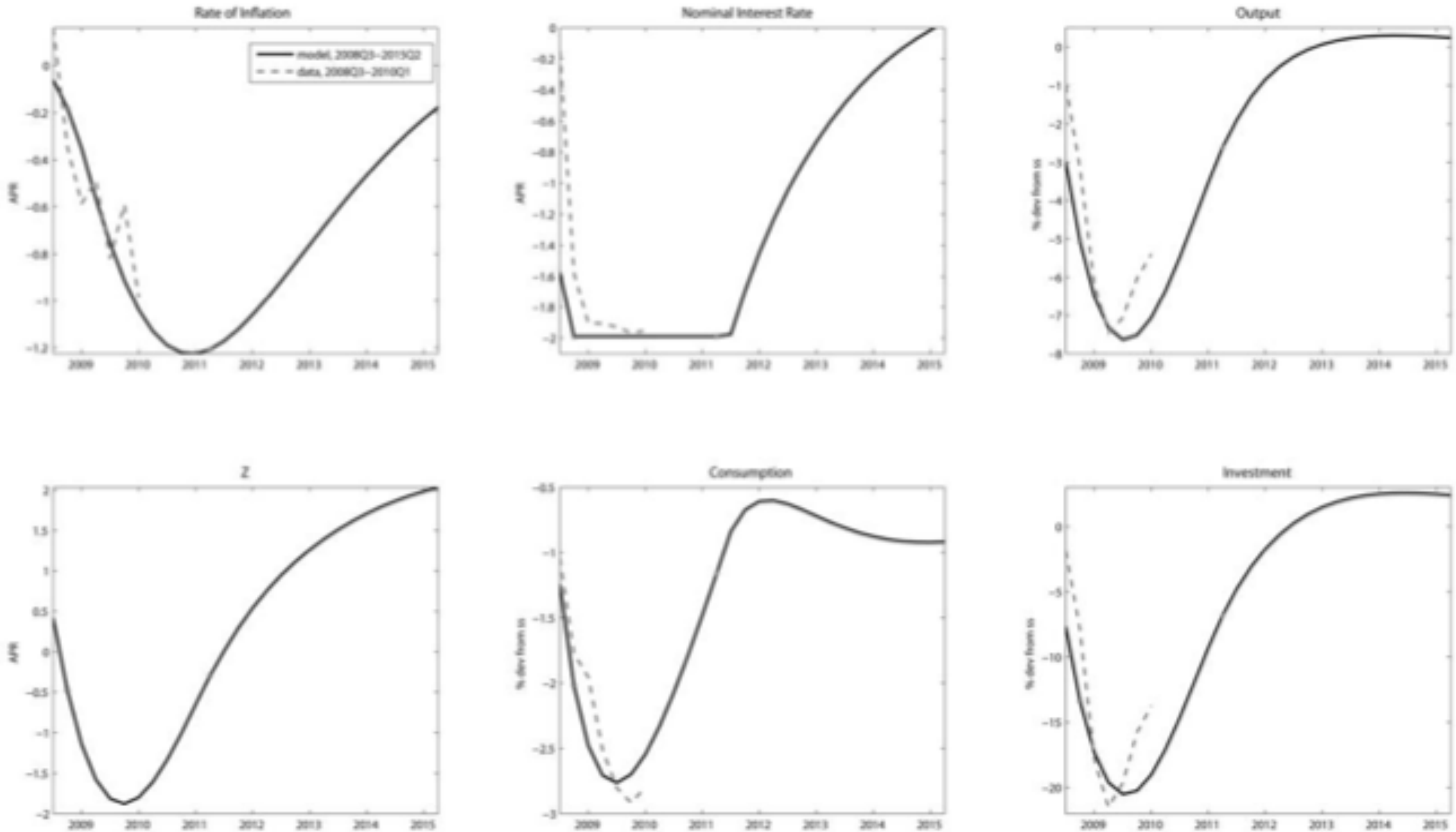
Multipliers for persistent increases in government purchases



Data and forecasts



Data and model impulse response functions



Next class

- *Optimal* monetary and fiscal policy in a liquidity trap

- Reading:

  ◇ Werning, "Managing a liquidity trap: Monetary and fiscal policy", MIT working paper

- First task: new Keynesian model in *continuous time*