Heterogeneity of Beliefs and Monetary Stabilization Policy

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Heterogeneity and Macroeconomic Modeling

- Wide agreement on a crucial issue for the next generation of policy models for central banks: need to allow for much more **heterogeneity** among the decision-making units (households, firms) in the economy

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  2. recent events: impact of COVID-19 dramatically different depending on one's position in the economy

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  - idiosyncratic risk: ex post heterogeneity of circumstances even if units are ex ante identical ["HANK" literature]
  - sectors differentially impacted by shocks [e.g., Guerrieri *et al.*, 2020]
  - heterogeneity of **expectations** [the focus here]

Why Heterogeneity of Expectations?

- This dimension of heterogeneity has not yet been the focus of too much work

  — probably because it obviously requires that one depart from the conventional assumption of **rational expectations,** unlike the other types of heterogeneity above

Why Heterogeneity of Expectations?

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  2. introducing **algorithmic models of expectation formation,** rather than requiring **model-consistency,** will make it much more tractable to introduce rich heterogeneity of other kinds — an essential feature of "agent-based models"

     - ABM's don't have to be based on crude heuristics with no connection to optimizing behavior

       — what is crucial is that the decision process of each agent be algorithmically specified

What Kind of Heterogeneity of Expectations?

- Approach used in Woodford (2019), Xie (2021), Woodford and Xie (2019, 2021):
  - households and firms decide how much to spend, what prices to set on the basis of **deductive forward planning** [hence can use information from **policy announcements**], but only look forward a **finite distance** into the future

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  - evaluate interim positions at the end of the planning horizon using a **value function** that has been learned inductively from past experience
  - even if all use the same (correct) model of the economy in their forward planning, **heterogeneity of beliefs** will result, in general, from **differences in planning horizons**

What Kind of Heterogeneity of Expectations?

Model can be solved **recursively:**

- Let y_t^j be spending by households with planning horizon j in period t, if each of these assumes that everyone else **also** has a planning horizon of length j

  — and similarly let π_t^j be rate of price increase by firms with planning horizon j [here ignore other types of heterogeneity]

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- Given this solution for y_{t+1}^0, π_{t+1}^0 as function of state reached then, optimizing choices y_t^1, π_t^1 can be determined as function of asset holdings, exogenous states at t, ...

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Model can be solved **recursively:**

- Given this solution, determine optimizing choices y_t^2, π_t^2; and so on
- Predicted evolution of aggregate variables is then simply

$$y_t = \sum_j \omega_j y_t^j, \qquad \pi_t = \sum_j \omega_j \pi_t^j$$

where $\{\omega_j\}$ indicate the population fractions with different planning horizons in reality [as opposed to the assumption of any of the boundedly-rational decision makers]

How Does the Heterogeneity Matter?

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    - it matters what the rule implies are possible counter-factual paths, under assumptions different from the evolution expected by the policymaker
    - given that **different** paths will be expected by different decision makers, after a given policy announcement, depending on their **planning horizons**

A Simple Example

- Suppose again that planning horizons are the **only** kind of heterogeneity across households and firms; and assume an **exponential distribution** of planning horizons, $\omega_j^h = \omega_j^f = (1-\rho)\rho^j$ for all $j \geq 0$, parameterized by $0 \leq \rho < 1$

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- Then aggregate inflation π_t and output gap y_t must satisfy

$$y_t = -\sigma(i_t + \Delta_t - \rho \mathrm{E}_t \pi_{t+1}) + \rho \mathrm{E}_t y_{t+1} + (1-\rho)(1-\beta) b_{t+1}$$

$$\pi_t = \kappa y_t + \rho \beta \mathrm{E}_t \pi_{t+1}$$

— note these reduce to the standard "NK-IS" and "NK-PC" equations when $\rho \to 1$

Optimal Policy?

- In this example, for **any** path of the financial wedge $\{\Delta_t\}$, it is possible to **completely stabilize** both inflation and output gap around their steady-state (target) values, even when i_t is constrained by an **effective lower bound**

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- Example of paths for $\{i_t, b_t\}$ consistent with this solution:

  - if Δ_t is small enough for $i_t = -\Delta_t$ to be consistent with the ELB, **offset** the financial wedge with reduction in safe interest rate, and set $b_{t+1} = 0$

Optimal Policy?

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- Example of paths for $\{i_t, b_t\}$ consistent with this solution:

  - if instead i_t cannot be set that low, reduce i_t **to the ELB,** and set

$$b_{t+1} = \frac{\sigma}{(1-\rho)(1-\beta)} \tilde{\Delta}_t$$

    where $\tilde{\Delta}_t \equiv \Delta_t + i_t$ is the part of the financial wedge that **is not offset** using interest-rate policy

Optimal Policy?

- Given that complete stabilization is possible, it might seem that a reasonable policy framework would be:
  - set i_t so as to **achieve the inflation target** (with no fiscal transfers), if this can be done while respecting the ELB
  - if ELB binds, reduce i_t to the ELB, and then increase b_{t+1} to the extent necessary to **achieve the inflation target**

  which (assuming that the inflation target can indeed be achieved at all times) should also stabilize the output gap

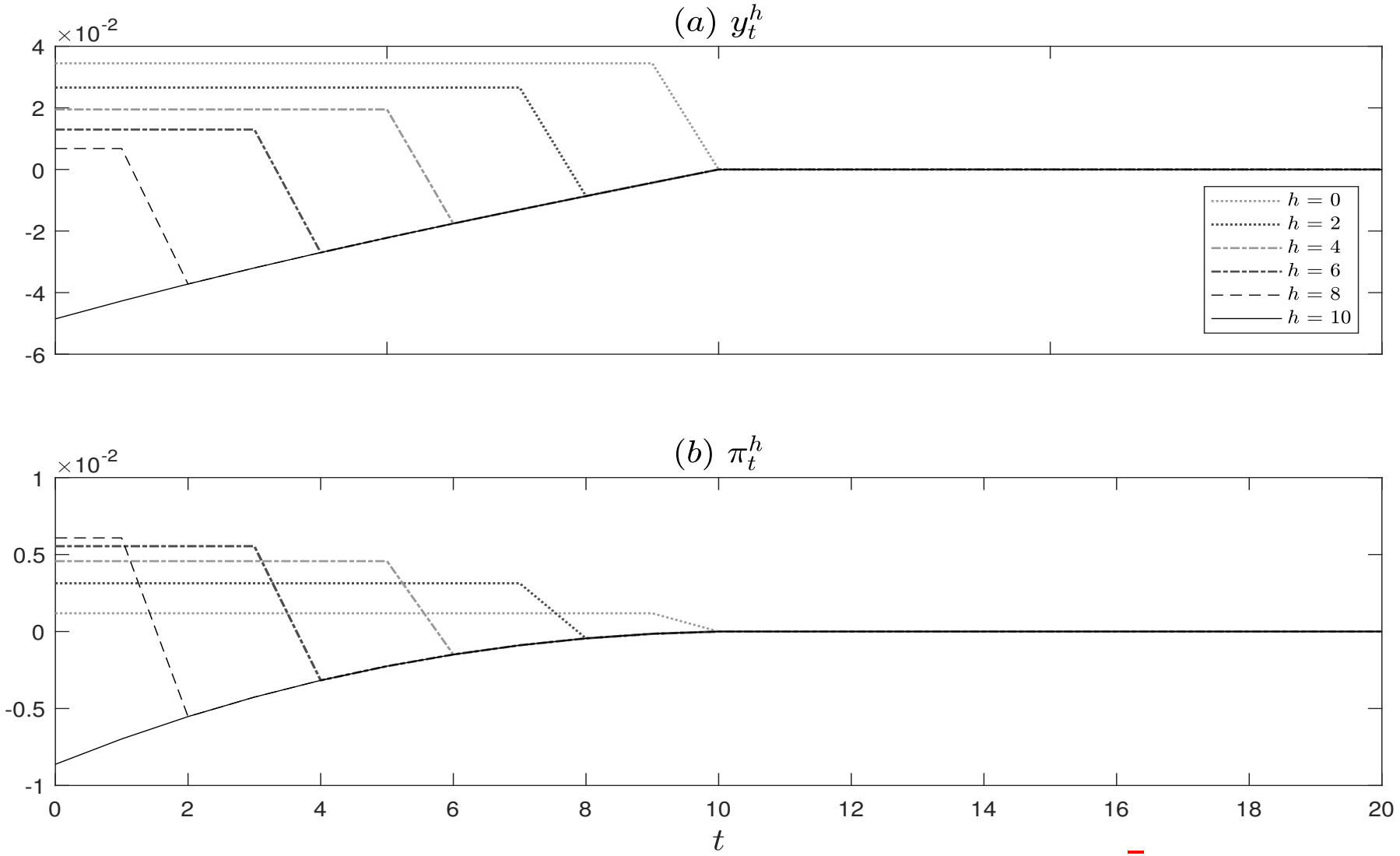
Optimal Policy?

- Problem: the solution described on previous slide **can't be achieved** with this understanding of policy

  — because the solution with $\pi_t = y_t = 0$ at all times depends on **some people** [those with short planning horizons] expecting that policy rule will imply **overshooting** of inflation target

  — while others [those with long planning horizons] expect that fiscal stimulus will be **insufficient to prevent under-shooting**

Paths Expected by Heterogeneous Planners



planning: exponential distribution, mean horizon $\bar{h} = 8$ qtr

shock: elevated financial wedge for 10 qtrs with certainty

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- Above paths optimal only if one **only** cares about stabilizing **aggregate** inflation and output

- Microfoundations of our model imply that max average utility corresponds to minimizing a quadratic loss function

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \left[\pi_t^2 + \alpha^{-1} \mathrm{var}(\pi_t^h) + \lambda_{agg} y_t^2 + \lambda_{disp} \mathrm{var}(y_t^h) \right]$$

where $\alpha =$ Calvo stickiness parameter, and $\lambda_{agg} > \lambda_{disp} > 0$

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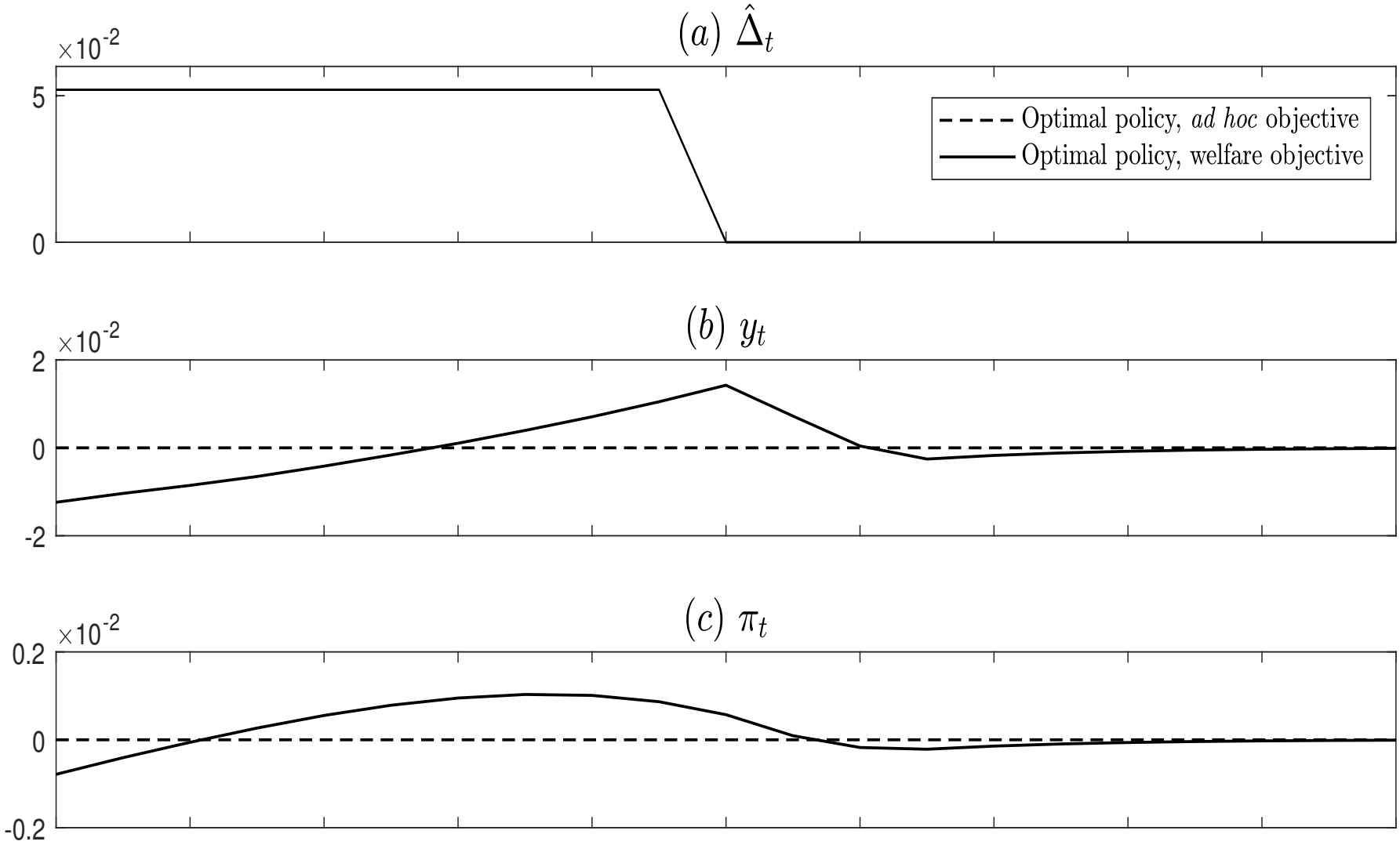
where $\alpha =$ Calvo stickiness parameter, and $\lambda_{agg} > \lambda_{disp} > 0$

- Not possible, in general, to completely stabilize π_t^h and y_t^h **for all** h**;** and second-best policy doesn't completely stabilize the aggregates

Second-Best Welfare-Optimal Policy



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not optimal to fully stabilize π or y, **even** from $t = 10$ onward

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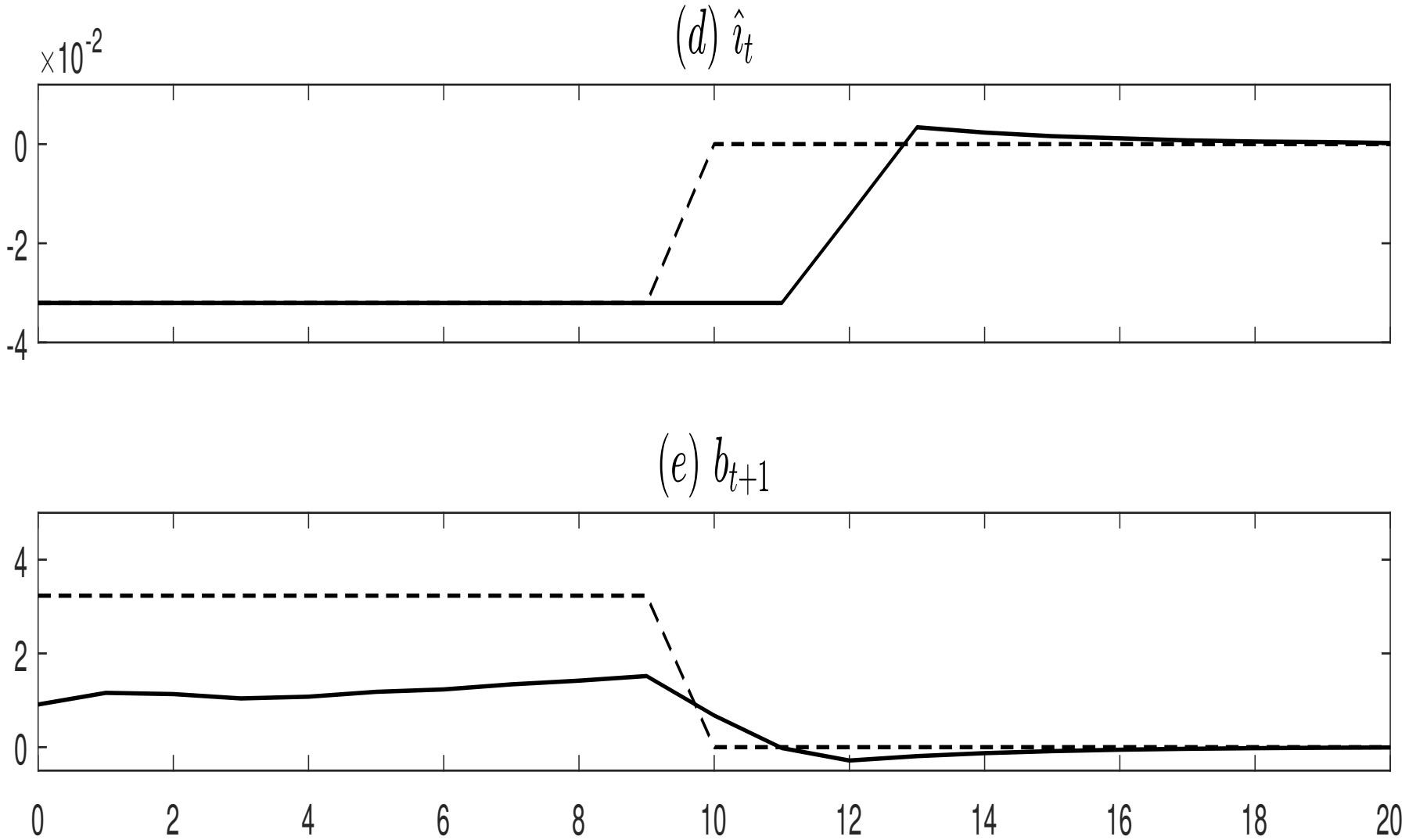

forward guidance regarding policy for $t \geq 10$ still useful

both policy instruments should be used

Conclusions

- One can introduce heterogeneous, boundedly rational expectations into an NK DSGE model
  - in a way that is **computationally tractable** (owing to recursive structure of equations)
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  - in a way that is **computationally tractable** (owing to recursive structure of equations)
  - and that still nests fully rational expectations as a **limiting case** (at least in simple environments)
- This would facilitate the introduction of **other forms of heterogeneity** as well
- And heterogeneity in the degree to which different people are capable of (or bother to) engage in deductive forward planning has important consequences for **optimal stabilization policy**