Monetary-Fiscal Interactions when Foresight is Limited

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  - fiscal policy not very suitable for stabilization — perhaps even ineffective [“Ricardian equivalence”]

  - important to **insulate** monetary policies from pressures from fiscal authorities [e.g., Maastricht treaty]

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  - fiscal policy not very suitable for stabilization — perhaps even ineffective ["Ricardian equivalence"]
  - important to **insulate** monetary policies from pressures from fiscal authorities [e.g., Maastricht treaty]

- But the GFC has required rethinking of these doctrines

Questions about the Orthodoxy

- Policy after the GFC: conventional monetary policy **constrained by the ZLB,** and revived interest in use of **"fiscal stimulus"** for stabilization purposes

  — resulting also in the return of questions about the need for **coordination** between monetary and fiscal authorities

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- GFC has also led to increased questions about the adequacy of **rational expectations equilibrium** analysis of alternative policies

  — always a rather heroic assumption, but especially in the case of **novel policies,** with which people would have had little prior experience (as with recent experiments with "forward guidance", and "fiscal stimulus" as responses to the ZLB)

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- We do, however, want to allow people some capacity for a **limited degree** of forward planning, in which they can take into account **announcements** of new policies, as well as the fact that some **unexpected** sort of crisis may have occurred

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- This is important both for understanding why a crisis like the GFC can be **so severe** [in the absence of a suitable policy response], and for analyzing policy tools such as **"forward guidance"**

Finite-Horizon Planning

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- Even in these artificial environments where set of feasible moves from any position is finite, not even the best professional players (human or AI) can **solve the game by backward induction,** and simply execute the optimal strategy [as REE analysis would assume]

Finite-Horizon Planning

- What the best programs (DeepMind, AlphaGo) actually do: each time one must move,

  1. **look forward** from one's current position a **finite number** of steps, calculating the possible positions that can be reached by finite sequences of moves [under a model of opponent play]

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  3. by backward induction from the nodes at which the tree search has been terminated [and value function applied], **assign a value** to each of the possible **initial moves** from the current position

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4. **select** the move with highest estimated value

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  — because even with advances in parallel computing [and even in these highly structured environments!], exhaustive tree search is too costly

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- Why do **any** forward planning at all?

  — because it is not feasible to learn and store an **exact** value function [the one that could be calculated, in principle, by backward induction]

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- Design trade-off:
  - *forward planning* allows use of **fine-grained information** about specific situation: because only undertaken for a given situation when it occurs — but **cost** grows explosively with planning horizon
  - *value function* **inexpensive** to apply (once learned), but only practical to learn to value **coarse description** of situation

Finite Planning Horizons in a Macro Model

- Illustration of how this approach can be used in macro modeling: consider the spending/saving decision of households

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- As in basic NK model, a single asset: riskless short-term nominal debt (yield i_t on which will be CB's policy instrument)

- Flow budget constraint of household i:

$$B^i_{t+1} \;=\; (1+i_t)\left[B^i_t(P_{t-1}/P_t) + Y_t - T_t - C^i_t\right]$$

where B^i_t is nominal debt maturing at date t, deflated by **period $t-1$ price level,** so that it is a **predetermined real variable**

— value of B^i_{t+1} is known as a result of choices at date t, though real purchasing power of that future wealth will depend on **expectations** about inflation between t and $t+1$

Household with k-Period Planning Horizon

- Household i problem in period t: choose spending plan $\{C_\tau^i(s_\tau)\}$ for periods $t \le \tau \le t+k$ to maximize

$$\hat{\mathrm{E}}_t^i \sum_{\tau=t}^{t+k} \beta^{\tau-t} u(C_\tau^i) + \beta^{k+1} v(B_{t+k+1}^i; s_{t+k})$$

subject to constraints

$$B_{\tau+1}^i = (1+i_\tau)\left[B_\tau^i(P_{\tau-1}/P_\tau) + Y_\tau - T_\tau - C_\tau^i\right]$$

for all $t \le \tau \le t+k$,

- Here $v(B_{\tau+1}^i; s_\tau)$ is the **value function** used to evaluate possible situations in a terminal state s_τ

Decisions with a Finite Planning Horizon

- Expectations about periods $t \leq \tau \leq t + k$ used in planning exercise:
    - **deduced from structural equations of model** (including monetary/fiscal policy rules) for periods t through $t + k$
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    - but no consideration of branches **beyond horizon** $t + k$ means aggregate conditions in period $t + j$ assumed to be determined by decisions of people who plan **only** $k - j$ **periods ahead**
- Just as household models **own** behavior in future period $t + j$ as if will only have horizon of length $k - j$ then, models all **other households and firms** as optimizing, but only having horizons of length $k - j$ in period $t + j$

Equilibrium with a Finite Planning Horizon

- Let Y_t^j, Π_t^j, i_t^j be the (counterfactual) output, inflation, and nominal interest rate in the case that all had a planning horizon of $j \geq 0$ periods; then **Euler equation** of representative household requires that for any $j \geq 1$,

$$u'(Y_t^j) \;=\; \beta(1 + i_t^j)\,\mathrm{E}_t[u'(Y_{t+1}^{j-1})/\Pi_{t+1}^{j-1}]$$

while for $j = 0$,

$$u'(Y_t^0) \;=\; \beta(1 + i_t^0)\, v_b(B_{t+1}^0;\, s_t)$$

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- These can be solved **recursively** for optimal expenditure by households with each possible planning horizon: use last eq'n to solve for Y_t^0; then $j = 1$ eq'n to solve for Y_t^1; etc.

Equilibrium with a Finite Planning Horizon

- Can similarly analyze finite-horizon version of the problem of a price-setting firm

- Similarly obtain a **recursive system** of FOCs:
  - equation for Π_t^0 depends only on Y_t^0
  - equation for Π_t^1 depends on Y_t^1, and **[model-consistent!]** expectations regarding Π_{t+1}^0, Y_{t+1}^0
  - and so on, for progressively longer planning horizons

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- Since can solve equations for behavior of households, firms with **any** planning horizon j, can also derive dynamics of aggregate variables in the case of an arbitrary **distribution of planning horizons** in population: simply define $Y_t = \sum_j \omega_j Y_t^j$, $\Pi_t = \sum_j \omega_j \Pi_t^j$

Equilibrium with Finite Planning Horizons

- Given evolution of the value functions [to specify below], complete system of structural equations are then:
  - Euler equations above
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Equilibrium with Finite Planning Horizons

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  - Euler equations above
  - flow budget constraints above
  - FOCs for inflation dynamics
  - equations specifying the monetary/fiscal policy regime
- A **finite** system of equations, with a **recursive** structure, for any assumed planning horizon k — or any distribution of planning horizons — for which we wish to analyze the predicted dynamics

Assumptions about the Value Function

- If a simple, repetitive environment has been maintained **long enough,** it makes sense to suppose that people can have **learned the correct value function** for that environment

  — in that case, outcome with finite-horizon planning is identical to REE outcome [regardless of the planning horizon h]

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- But if a **novel policy** is announced, while this should be taken into account in people's forward planning, it should **not** immediately change the value functions used to evaluate terminal states

Assumptions about the Value Function

- Here we are interested in a scenario in which
  - an **unusual shock** occurs, and a **novel policy** is announced in response to it

    — little prior experience with either this shock or this policy $\Rightarrow$ value functions don't condition on either, and so do not immediately change

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  - at the time of the shock occurrence and policy announcement, it is understood that both may well continue beyond some people's planning horizons ⇒ **finiteness of horizons** matters
  - nonetheless, shock (and associated policy response) are **transitory** enough that the adjustment of the value functions can be neglected ⇒ value-function adjustment dynamics play no role in this paper [but see instead Woodford (2019), Xie (2020)]

The Setting

We consider the effects of alternative monetary/fiscal policies under the following scenario:

- Prior to date $t = 0$, we suppose that the economy has for a long time been in a regime under which
  - there are **no financial frictions** [hence natural rate of interest $r_t^n = r^* > 0$]
  - government purchases are constant, gov't budget is balanced each period, and
  - the **inflation target** π^* has been consistently achieved [ZLB is no obstacle to this]

and as a result, households and firms have learned the **value functions** that are appropriate to such a regime

The Setting

- This means that we assume that households learn the **value function**

$$v(B) \;=\; \frac{1}{1-\beta} u(\bar{Y} \;+\; (1-\beta)B/\bar{\Pi}),$$

where B is the household's **own** anticipated holdings of real debt at the end of its planning horizon, and $\bar{Y}, \bar{\Pi}$ are the steady-state levels of output and inflation under the previous stationary regime

— and we assume that this remains **unchanged** over the course of the scenario discussed below

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- Note that we assume no dependence on state variables other than one's own asset position

— in particular, no dependence on the level of public debt that may have been issued as a result of a novel policy (responding to a novel situation)

The Setting

We consider the effects of alternative monetary/fiscal policies under the following scenario:

- At $t = 0$, unexpected shock occurs, creating a **wedge** $\Delta > 0$ between the return on **safe assets** [balances held at CB] and other assets ["shock to safe asset demand"]

  — as a result of which real return on safe assets required in steady state is now $r_t^n = r^* - \Delta < 0$

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- Economy remains in this **“crisis state”** until some date T [that may be random]

  — from $t = T$ onward, economy reverts to **“normal state”** in which financial wedge is again zero, and is expected to be zero **forever after**

Numerical Calibration

Assumptions used in our numerical illustrations of the model's implications:

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- We calibrate the model following Eggertsson (2010), who proposes a calibration in which a shock of this kind produces a "Great Depression," in the absence of any change in monetary or fiscal policy
  - $r^* - \Delta = -.01 \Rightarrow$ real rate [on safe assets] req'd for zero output gap falls to -4% per annum
  - $\delta = 0.903 \Rightarrow$ expected duration of "crisis state" nearly 10 quarters

Numerical Calibration

- Eggertsson (2010) obtains "Great Depression" outcome under assumptions of
  - rational expectations
  - monetary policy committed to inflation target of zero (price stability)
- We instead assume that "normal" policy maintains inflation at target rate of **2 percent** per annum $\Rightarrow$ ZLB a less severe constraint in our case (for same size of real shock)

  — and also consider consequences of shorter planning horizons

How Finite Horizons Matter

- First consider what should happen when the crisis occurs, if there is **no change** in either fiscal or monetary policy:

  — constant path of real public debt, interest-rate policy ensures that inflation equals target rate π^* if consistent with ZLB [and otherwise, interest rate **as low as possible**]

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  — constant path of real public debt, interest-rate policy ensures that inflation equals target rate π^* if consistent with ZLB [and otherwise, interest rate **as low as possible**]

- And consider for simplicity the case in which there is a **constant probability** of reversion to the "normal state" each period

- Consequence: a **Markovian** solution, in which $\pi_t = \underline{\pi} < \pi^*, y_t = \underline{y} < 0$ as long as the financial wedge persists

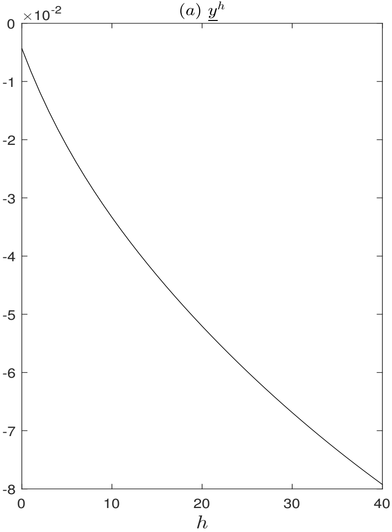
  — then immediate return to $\pi_t = \pi^*, y_t = y^*$ in all periods, once financial wedge is again zero

How Finite Horizons Matter

- Like the REE analysis in Eggertsson and Woodford (2003), except that contraction/disinflation during the crisis is **smaller,** the shorter are agents' horizons

  — still, ZLB can result in serious crisis, as long as h is **not too short**

Markov Solution with No Policy Response



Markovian expectations for agents with different horizons h

How Finite Horizons Matter

- Another important difference:
  - under REE: lump-sum tax/transfer policies are **irrelevant** [Ricardian Equivalence]
  - with FH planning: lump-sum transfers can increase aggregate demand if increased public debt remains outstanding **beyond** (at least some people's) **planning horizons**

Fiscal Transfers and Aggregate Demand

- Consider a policy regime in which the path of **real public debt** $\{B_{t+1}\}$ is specified exogenously [but may be **state-contingent:** in particular, may respond to the evolution of the financial wedge]

Fiscal Transfers and Aggregate Demand

- Then the spending plans of households with different planning horizons must satisfy

$$u'(Y_t^j) \;=\; \beta(1 + i_t^j + \Delta_t)\,\mathrm{E}_t[u'(Y_{t+1}^{j-1})/\Pi_{t+1}^{j-1}]$$

for each $j \geq 1$, while for $j = 0$,

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- The final equation now uses the fact that [since households use their understanding of the newly announced path of public debt in their forward planning] a household must anticipate holding $B_{t+h}^0 = B_{t+1}$, the exogenous supply of public debt, in the period when it reaches its planning horizon

Fiscal Transfers and Aggregate Demand

$$u'(Y_t^0) \;=\; \beta(1 + i_t^0 + \Delta_t)\, v'(B_{t+1})$$

- Why we would obtain **Ricardian equivalence** under the REE analysis: value function $v(B^0_{t+1}; s_t)$ should include [as part of the state s_t] the way in which household's **tax obligations** after date t are different because of any non-zero B_{t+1} [public debt not retired by date t]

  — as a result, a policy that increases B_{t+1} does **not** result in a different value of $v'(B_{t+1};\, s_t)$

Fiscal Transfers and Aggregate Demand

$$u'(Y_t^0) \;=\; \beta(1 + i_t^0 + \Delta_t)\, v'(B_{t+1})$$

- Instead, we assume a **coarse value function** that does not take account of the change in future tax obligations **beyond the household's planning horizon**

— as a result, $v'(B_{t+1})$ is a **decreasing function of B_{t+1}**

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- Thus a higher anticipated B_{t+h} requires household's plan to involve higher anticipated Y_{t+h}^0

  — and working back recursively, also a higher Y_t^h [for any planning horizon h, and any anticipated paths of interest rate and inflation]

Fiscal Transfers and Aggregate Demand

- Log-linearizing equations around the old steady-state values: define deviations

$$y_t^j \equiv \log(Y_t^j/\bar{Y}), \qquad \pi_t \equiv \log(\Pi_t/\bar{\Pi}), \qquad b_t \equiv B_t/(\bar{\Pi}\bar{Y}),$$

$$\hat{\imath}_t \equiv \log\left(\frac{1+i_t}{1+\bar{\imath}}\right), \qquad \hat{\Delta}_t \equiv \frac{\Delta_t}{1+\bar{\imath}}.$$

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- Household FOCs become

$$y_t^j = -\sigma(\hat{\imath}_t^j + \hat{\Delta}_t - \mathrm{E}_t \pi_{t+1}^{j-1}) + \mathrm{E}_t y_{t+1}^{j-1}$$

for each $j \geq 1$, and

$$y_t^0 = -\sigma(\hat{\imath}_t^0 + \hat{\Delta}_t) + (1-\beta) b_{t+1}.$$

Fiscal Transfers and Stabilization at the ZLB

- Suppose that we further consider an example in which
  - we have an **exponential distribution** of planning horizons, $\omega_j = (1-\rho)\rho^j$ for some $0 < \rho < 1$; and
  - monetary policy uses interest rate to **offset the financial wedge** unless constrained by the ZLB

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  - monetary policy uses interest rate to **offset the financial wedge** unless constrained by the ZLB
- Then aggregate inflation π_t and output gap y_t must satisfy

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

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

where $\tilde{\Delta}_t =$ part of the financial wedge that cannot be offset by interest rate (owing to the ZLB)

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

Fiscal Transfers and Stabilization at the ZLB

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- If fiscal wedges are never too large [so that $\tilde{\Delta}_t = 0$ at all times], this policy with $b_{t+1} = 0$ at all times suffices to maintain $\pi_t = y_t = 0$ at all times

  — but if instead $\tilde{\Delta}$ follows a 2-state Markov chain [positive during "crisis"], then with $b_{t+1} = 0$ at all times, Markovian equilibrium with $\pi_t < 0$, $y_t < 0$ in crisis

Fiscal Transfers and Stabilization at the ZLB

$$y_t = -\sigma(\tilde{\Delta}_t - \rho \mathrm{E}_t \pi_{t+1}) + \rho \mathrm{E}_t y_{t+1} + (1-\rho)(1-\beta) b_{t+1}$$
$$\pi_t = \kappa y_t + \rho\beta \mathrm{E}_t \pi_{t+1}$$

- However, it is still possible to achieve $\pi_t = y_t = 0$ at all times even when ZLB binds, if fiscal transfers ensure that

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

— in the Markovian scenario, this requires lump-sum transfers when wedge increases, and then lump-sum taxes to restore real public debt to previous level once financial wedge dissipates

— no need to commit to anything other than strict IT and constant (small) public debt after financial wedge shrinks

The Importance of Monetary Accommodation

- This might make it seem that **fiscal policy can be solely responsible** for stabilization, with monetary policy simply pursuing a fixed inflation target at all times

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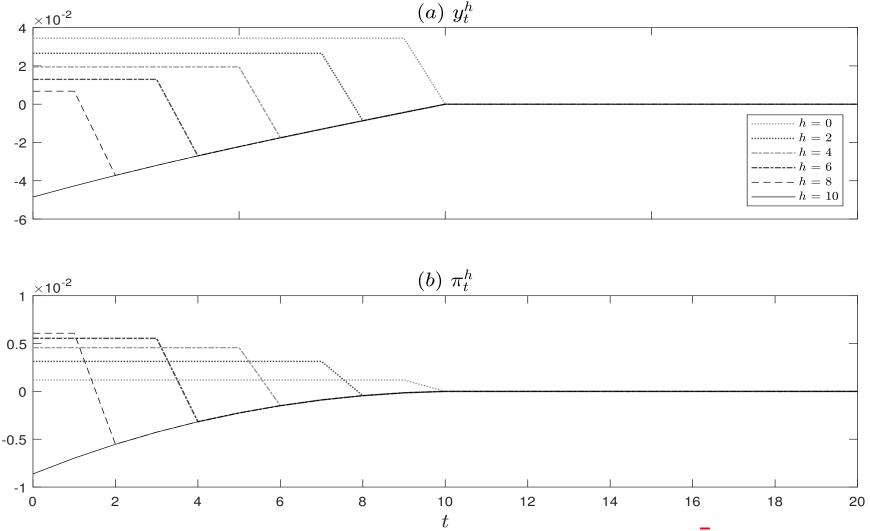
- This might make it seem that **fiscal policy can be solely responsible** for stabilization, with monetary policy simply pursuing a fixed inflation target at all times

- Instead, no: the solution above with complete stabilization of aggregate π and y **achieves the fixed inflation target at all times** — but does not involve all agents **expecting that to be the case**

  — agents with different planning horizons expect different paths of π_t and y_t

  — those with short horizons must be expecting an **inflationary boom**

Paths Expected by Heterogeneous Planners



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

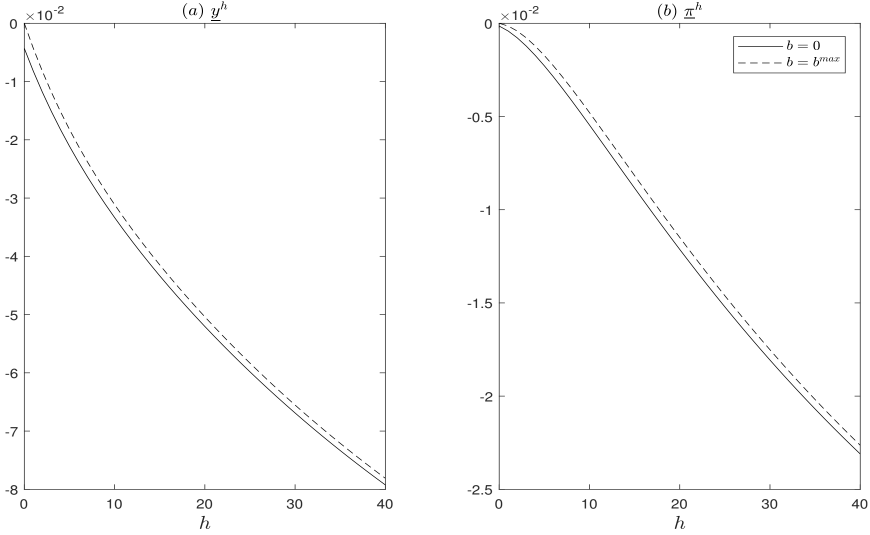
shock: elevated financial wedge for 10 qtrs with certainty

The Importance of Monetary Accommodation

- If instead it were understood that CB is committed to **prevent any overshooting** of its long-run inflation target, then the maximum degree of stimulus that can be achieved through fiscal transfers is modest, **no matter how large** the transfers

  — because all but the shortest-horizon planners will expect interest-rate policy to **offset** the "excess" fiscal stimulus, within their planning horizon

Markov Solution with Strict Inflation Target



Markovian expectations for agents with different horizons h

The Relevance of Forward Guidance

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- 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 α = Calvo stickiness parameter, and $\lambda_{agg} > \lambda_{disp} > 0$

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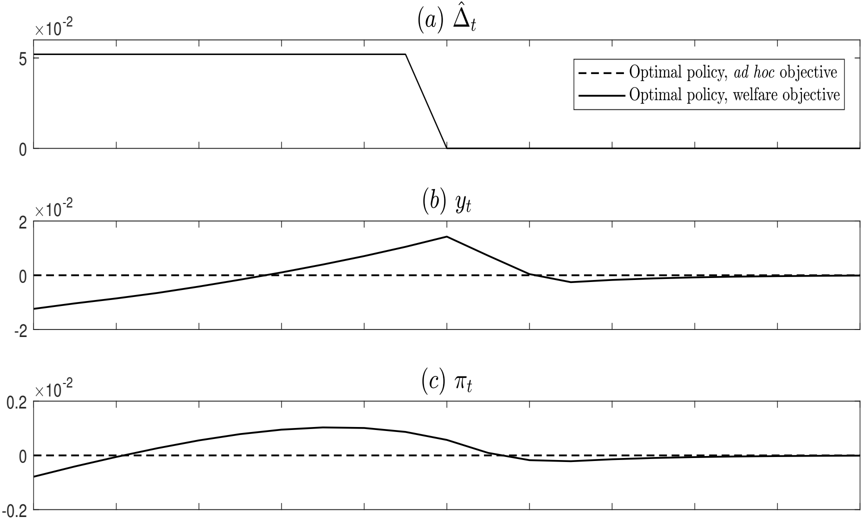
- Not possible, in general, to completely stabilize π_t^h and y_t^h **for all** h

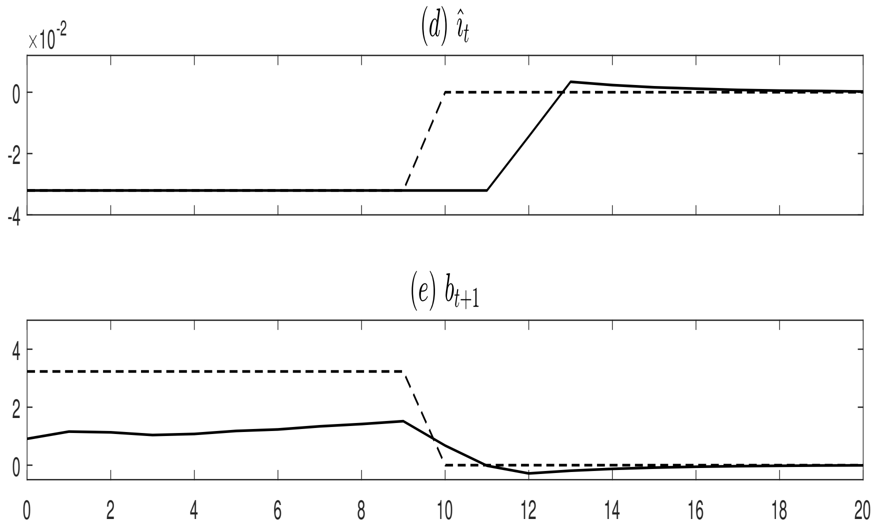
Second-Best Welfare-Optimal Policy



shock: shock: elevated financial wedge for 10 qtrs with certainty

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

Second-Best Welfare-Optimal Policy



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

both policy instruments should be used

Conclusions

- Allowing for finiteness of planning horizons matters:
  - forward guidance a less powerful tool
  - transfer policy instead **more** powerful

Conclusions

- Allowing for finiteness of planning horizons matters:
  - forward guidance a less powerful tool
  - transfer policy instead **more** powerful
- But the availability of the gov't budget as an additional instrument of stabilization policy doesn't **eliminate** the usefulness of CB commitment to allow **temporary** overshooting of its long-run inflation target
  - both **during** the "crisis" period
  - and in its immediate **aftermath** (when complete stabilization would again be possible)