First Paper

- synthesze theoretical literature
- emphasize GE
- bridge to expectations data

Second Paper

- a new take on how to offer forward guidance

Myopia and Anchoring

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Belief Frictions = Myopia and Anchoring

- Starting point: representative-agent model of the form

$$a_t = \varphi \xi_t + \delta \mathbb{E}_t[a_{t+1}]$$

  - nests: AP, Dynamic IS, NKPC, investment/entry in large industries
  - underneath: dynamic beauty contest

- Add: **dispersed private information or RI**
  - imperfect knowledge of, or attention to, shocks (first-order uncertainty)
  - doubts about attention and responsiveness of others (higher-order uncertainty)

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- Main result: under conditions, observational equivalence with

$$a_t = \varphi \xi_t + \omega_f \delta \mathbb{E}_t \left[a_{t+1}\right] + \omega_b a_{t-1}$$

  - $\omega_f < 1$ (myopia) and $\omega_b > 0$ (anchoring)
  - both distortions increase with strategic complementarity/GE
  - may loom at macro level but may not be easily detected in usual micro data

Framework

- Aggregate outcome satisfies

$$a_t = \overline{\mathbb{E}}_t \left[\sum_{k \geq 0} \beta^k \varphi \xi_{t+k} \right] + \gamma \overline{\mathbb{E}}_t \left[\sum_{k \geq 0} \beta^k a_{t+k+1} \right]$$

  - a_t is endogenous outcome (π_t, C_t, I_t, asset price ...)
  - ξ_t is exogenous fundamental (marginal cost, dividend ...)
  - γ controls GE feedback, or strategic complementarity

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- Same as game with continuum of long-lived players and best responses

$$a_{it} = \mathbb{E}_{it} \left[\varphi \xi_t + \beta a_{it+1} + \gamma a_{t+1} \right]$$

  - $\beta \geq 0$, $\gamma \geq 0$, $\beta + \gamma < 1$

Departure: Incomplete Information and Higher-Order Uncertainty

- Why this particular departure?
  - dispersed private information (Hayek, Lucas)
  - rational inattention and costly cognition (Sims)
  - doubts about others' awareness and response (higher-order uncertainty)
  - a form of bounded rationality consistent with REE

- Key implications:
  - expectations of future outcomes $\neq$ expectations of future fundamentals
  - outcomes depend on HOB (higher-order beliefs)
  - PE and GE play distinct roles, γ regulates relative importance of HOB

Baseline Specification

- Fundamental follows AR(1)

$$\xi_t = \rho \xi_{t-1} + \eta_t = \frac{1}{1-\rho L}\eta_t$$

where $\eta_t \sim \mathcal{N}(0,1)$ and $\rho \in (0,1)$

- Information given by history of private signals:

$$x_{it} = \xi_t + u_{it},$$

where $u_{it} \sim_{\text{iid}} \mathcal{N}(0,\sigma^2)$ and $\sigma \geq 0$ parameterizes the friction

Equivalence Result

Proposition (*Observational Equivalence*)

Incomplete-info outcome is replicated by a complete-info economy in which

$$a_t = \varphi \xi_t + \delta \omega_f \mathbb{E}_t [a_{t+1}] + \omega_b a_{t-1}$$

for a unique pair of (ω_f, ω_b) *which is such that* $\omega_f < 1$ *and* $\omega_b > 0$*.*

- myopia : $\omega_f < 1$
- anchoring : $\omega_b > 0$
- both encompass HOB

Understanding Myopia ($\omega_f < 1$)

- To illustrate: think of NKPC, fix $\xi_t = 0$ for $t \neq 1$, and let $\xi_1 \sim \mathcal{N}(0, \sigma_\xi^2)$

- Response of inflation at $t = 0$ to news about MC at $t = 1$

$$\begin{aligned}\pi_0 &= \kappa\delta\theta\, \overline{\mathbb{E}}_0[\xi_1] + \delta(1-\theta)\delta\theta\, \overline{\mathbb{E}}_0[\pi_1] \\ &= \kappa\delta\theta\, \overline{\mathbb{E}}_0[\xi_1] + \delta(1-\theta)\delta\theta\, \overline{\mathbb{E}}_0\left[\kappa\overline{\mathbb{E}}_1[\xi_1]\right]\end{aligned}$$

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- Information:
  - firm i observes $x_i = \xi_1 + \epsilon_i$ at $t = 0$;
  - no learning at $t = 1$
- Implied beliefs:

$$\begin{aligned}\mathbb{E}_{i,0}[\xi_1] = \mathbb{E}_{i,1}[\xi_1] &= \lambda x_i \\ \overline{\mathbb{E}}_0[\xi_1] = \overline{\mathbb{E}}_1[\xi_1] &= \lambda \xi_1 \qquad \lambda \equiv \frac{\sigma_\xi^2}{\sigma_\xi^2 + \sigma_\epsilon^2} \\ \overline{\mathbb{E}}_0[\overline{\mathbb{E}}_1[\xi_1]] &= \lambda^2 \xi_1\end{aligned}$$

$\Rightarrow$ as if the news is discounted, more discounting with HOB

Understanding Anchoring ($\omega_b > 0$)

- Anchoring, or momentum, hinges on learning
- Basic intuition: in Kalman filter, past belief shows up as a state variable

$$\overline{\mathbb{E}}_t[\xi_t] = (1-G)\overline{\mathbb{E}}_{t-1}[\xi_t] + G\xi_t$$

- Similar logic in our setting except that
  - anchoring reinforced by higher-order uncertainty
  - relevant state variable is a_{t-1} (magic: a_{t-1} is a summary statistic of HOB)

The Role of GE Feedback

Proposition (*GE*)

Both distortions intensify ($\omega_f \downarrow$, $\omega_b \uparrow$) with stronger complementarity/GE

- Higher complementarity in price setting $\rightarrow$ more backward-looking inflation
- Larger Keynesian multiplier $\rightarrow$ more discounting and habit in Euler condition

Monetary Policy and Aggregate Demand

- Consumption function (PIH) plus market clearing $(y = c)$ give

$$c_t = -\sum_{k=0}^{\infty} \chi^k \overline{\mathbb{E}}_t[r_{t+k}] + \underbrace{(1-\chi)}_{\gamma} \sum_{k=0}^{\infty} \theta^k \overline{\mathbb{E}}_t[c_{t+k+1}]$$

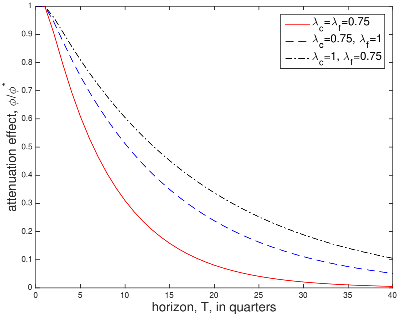
- Reduces to $c_t = -r_t + \mathbb{E}_t[c_{t+1}]$ with complete info, but not without
- Applying our result $\Rightarrow$ myopia toward future MP $+$ habit

$$c_t = -r_t + \omega_f \mathbb{E}_t[c_{t+1}] + \omega_b c_{t-1}$$

  - both distortions increase with slope of Keynesian cross (captured by γ)
  - suggests role of expectations particularly important in HANK
  - see also Farhi and Werning (2018)

Forward Guidance (Angeletos and Lian, AER 2018)

- Application: ZLB up to $t = T - 1$, response to news about R_t at $t = T$
- Full NK model: additional feedback between AD and AS (multi-layer game)



- Even a tiny perturbation can have huge effects as $T \to \infty$
- Front-loading fiscal stimuli, paradox of flexibility, neo-Fisherian effects...

Macro vs Micro

- Pervasive gap between macro and micro
  - C: estimated habit much smaller in micro data (Havranek et al, 2017)
  - I: type of IAC used in DSGE inconsistent with standard Q theory as well as with literature that studies plant-level investment dynamics
  - π: menu-cost models that match price data (Golosov & Lucas etc) don't produce backward-looking feature of hybrid NKPC
  - AP: Samuelson dictum (Jung and Shiller, 2005).
- Our results help merge the gap
  - mechanism: GE and HOB
  - distinct from, but complementary to, Mackowiak & Wiederholt (2009), inattention etc
- Also: usual micro-to-macro doesn't work!
  - need to augment standard micro data (choice date) with surveys of expectations (belief data)

Evidence on Expectations

- Coibion and Gorodnichenko (2015): average forecast error

$$\pi_{t+k} - \overline{\mathbb{E}}_t[\pi_{t+k}] = K_{CG} \left(\overline{\mathbb{E}}_t[\pi_{t+k}] - \overline{\mathbb{E}}_{t-1}[\pi_{t+k}] \right) + v_{t+k,t}$$

  - $K_{CG} > 0$: correlated forecast errors, under reaction to news
  - consistent with incomplete info, level-K thinking, and cognitive discounting

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  - consistent with incomplete info, level-K thinking, and cognitive discounting

- Bordalo, Gennaioli, Ma, Shleifer (2019): individual forecast error

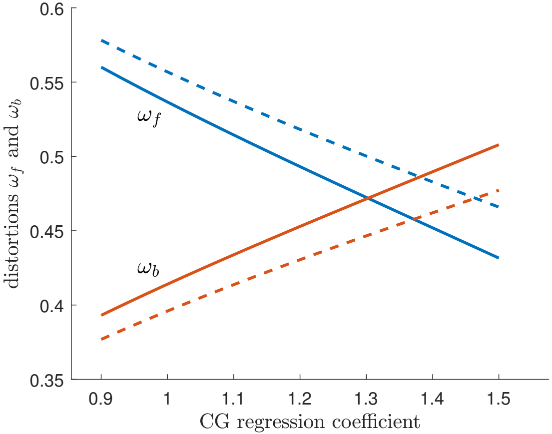
$$\pi_{t+k} - \mathbb{E}_{it}[\pi_{t+k}] = K_{BGMS}(\mathbb{E}_{it}[\pi_{t+k}] - \mathbb{E}_{it-1}[\pi_{t+k}]) + v_{i,t+k}$$

  - $K_{BGMS} < 0$: violation of rationality, over reaction to news
  - inconsistent with level-K thinking and cognitive discounting
  - consistent with incomplete information plus overconfidence

Extension: Adding Overconfidence

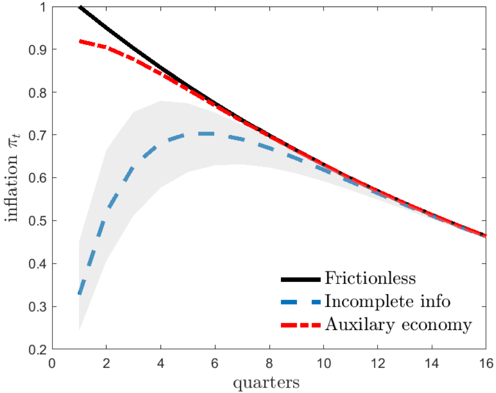
- Over- (or under-) confidence: perceived frictions $\widehat{\sigma}$ differs from actual σ
  - in line with behavioral lit on overconfidence; see also Kohlhas and Broer (2019); but here GE implications
- With $\widehat{\sigma} < \sigma$, consistent with both CG and BGMS
  - CG: informative about $\widehat{\sigma}$ and aggregate IRFs
  - BGMS: informative about σ and individual over/under-confidence, but uninformative about aggregate IRFs

Theory Meets Expectations Data (and vice versa)



Note: The distortions as functions of the proxy offered in CG (2015). The solid lines correspond to a stronger degree of strategic complementarity, or GE feedback, than the dashed one.

"Micro to Macro"



Predicted Inflation Response
$\rightarrow$ Matches Estimated Hybrid NKPC

Auxiliary economy: incomplete-info $\mathbb{E}[\xi]$ and complete-info $\mathbb{E}[\pi]$
$\rightarrow$ Highlights Most Effect Due to GE / HOB

Managing Expectations

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December 6, 2019

How to Manage Expectations?

- Instruments: “will maintain 0% interest rates for τ quarters”
- Targets: “will bring unemployment down to $Y\%$’

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Instrument Communication

August 2011: "The Committee [FOMC] currently anticipates ... exceptionally low levels for the federal funds rate at least through mid 2013."

January 2012: horizon extended to " ... at least through late 2014."

September 2012: horizon extended to " ... at least through mid 2015 ."

Target Communication (reserved?)

December 2012: "... as long as the unemployment rate remains above 6 1/2 percent, inflation between one and two years ahead is projected to be no more [than 2.5%], and longer-term inflation expectations continue to be well anchored.

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Target Communication (resolute?)

"do whatever it takes" (and perhaps won't bother to tell you *how*)

Instrument vs Target Communication

- Reason to prefer one over the other?
- **NO** in benchmark with
  (i) Full credibility
  (ii) No future shocks (or policy contingent on them)
  (iii) Rational Expectations + Common Knowledge

"Ramsey world"

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- ~~**NO** in benchmark with~~ ~~**"Ramsey world"**~~
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Our focus

Relax (iii) and explore role of bounded rationality

Main Lesson

Optimal Forward Guidance

- Instrument communication when GE feedback is weak
- Target communication when GE feedback is strong

Stop talking about R and start talking about u, Y when:

- ✓ long ZLB
- ✓ steep Keynesian cross
- ✓ strong financial accelerator

Rationale: help minimize

- ✓ agents' need to "reason about the economy"
- ✓ distortion due to bounded rationality
- ✓ lack of confidence

Model

$C = \int_i c_i \, \mathrm{d}i$ = average action today
Y = outcome (target) in the future
τ = instrument in the future

$$c_i = (1 - \gamma)\mathbb{E}_i[\tau] + \gamma \mathbb{E}_i[Y]$$

$\gamma \in (0, 1)$ parameterizes GE feedback

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$\gamma \in (0,1)$ parameterizes GE feedback

Story (microfoundation in paper)

ZLB today, but not tomorrow

C = spending today; Y = income today plus tomorrow

τ = minus interest rate tomorrow (or for how long thereafter)

γ = Keynesian multiplier

Model

Final outcome depends on realized behavior and policy

$$Y = (1 - \alpha)\tau + \alpha C$$

$\alpha \in (0, 1)$ parameterizes direct policy effect

Story (microfoundation in paper)

Loose policy tomorrow $\rightarrow$ higher output tomorrow

The Model (just 2 equations!)

$$c_i = (1-\gamma)\mathbb{E}_i[\tau] + \gamma\mathbb{E}_i[Y] \tag{1}$$

$$Y = (1-\alpha)\tau + \alpha C \tag{2}$$

The Model (just 2 equations!) and the Key Issue

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- No guidance: Agents have to forecast both τ and Y
- Instrument communication: know τ, have to think about Y
- **Target communication**: know Y, have to think about τ

Timing

$t = 0$ (FOMC meeting): PM sees θ (ideal point) and announces

either $\tau = \hat{\tau}$ (IC) or $Y = \hat{Y}$ (TC)

$t = 1$ (liquidity trap): Agents form beliefs and choose c_i

$t = 2$ (exit): C, τ and Y are realized

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The Policy Problem

$$\min_{\theta \mapsto \{\text{message}, (\tau, Y)\}} \mathbb{E}[(1-\chi)(\tau-\theta)^2 + \chi(Y-\theta)^2]$$

s.t. (τ, Y) is implementable in equil given

eq. (1)-(2) and message $\tau = \hat{\tau}$ or $Y = \hat{Y}$

Frictionless, REE Benchmark

Benchmark $\equiv$ representative, rational and attentive agent

(CK of both announcement and rationality)

$\Longrightarrow$ no error in predicting behavior of others:

$$\mathbb{E}_i[C] = C$$

$\Longrightarrow$ any equilibrium satisfies

$$c_i = C = Y = \tau$$

$\Longrightarrow$ irrelevant whether PM announces τ or Y

(equivalence of primal and dual problems)

Friction: Lack of CK / Anchored Beliefs

- Assumption: Lack of CK of announcement

  Let $X \in \{\tau, Y\}$ be the announcement. Agents are rational and attentive but think only fraction $\lambda \in [0,1]$ of others is attentive:

$$\mathbb{E}_i[X] = X \qquad \mathbb{E}_i[\bar{\mathbb{E}}[X]] = \lambda \mathbb{E}_i[X]$$

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- Convenient proxy for
  - HOB in incomplete-info settings
  - Level-K Thinking: same essence, but a small "bug"
  - Cognitive discounting: same for GE, but adds PE distortion

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- Convenient proxy for
  - HOB in incomplete-info settings
  - Level-K Thinking: same essence, but a small “bug”
  - Cognitive discounting: same for GE, but adds PE distortion
- Key shared implication: Anchored Beliefs

$$\bar{\mathbb{E}}[[C] = \lambda C$$

Preview of Arguement

1. Friction attenuates power of FG under IC

   Angeletos & Lian (AER2018), Farhi & Werning (2018), Gabaix (2018)

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3. Role of GE: As $\gamma \uparrow$, first distortion $\uparrow$ and second $\downarrow$

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2. Friction amplifies power of FG under TC

3. Role of GE: As $\gamma \uparrow$, first distortion $\uparrow$ and second $\downarrow$

4. Optimality: TC $\succ$ IC if and only if γ large enough

IC: Game after Announcing τ

$$C = (1-\gamma)\bar{\mathbb{E}}[\tau] + \gamma\bar{\mathbb{E}}[Y]$$

IC: Game after Announcing τ

(reasoned by agents)

$$= (1-\alpha)\bar{\mathbb{E}}[\tau] + \alpha\bar{\mathbb{E}}[C]$$

$$C = (1-\gamma)\bar{\mathbb{E}}[\tau] + \gamma\bar{\mathbb{E}}[Y]$$

$= \tau$ (fixed by FG)

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$\alpha\gamma \in (0,1)$

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- Game of **complements**

  "I expect less spending and income, so I spend less"

- Friction **reduces** effectiveness of FG

  Stylizes Angeletos & Lian (2018), Farhi & Werning (2018), Gabaix (2018), Garcia-Schmidt & Woodford (2018)

TC: Game after Announcing Y

$$C = (1-\gamma)\bar{\mathbb{E}}[\tau] + \gamma\bar{\mathbb{E}}[Y]$$

TC: Game after Announcing Y

(reasoned by agents)

$$= \frac{1}{1-\alpha}\bar{\mathbb{E}}[Y] - \frac{\alpha}{1-\alpha}\bar{\mathbb{E}}[C]$$

$$C = (1-\gamma)\bar{\mathbb{E}}[\tau] + \gamma\bar{\mathbb{E}}[Y]$$

$= Y$ (fixed by FG)

TC: Game after Announcing Y

(reasoned by agents)

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$$C = (1-\gamma)\bar{\mathbb{E}}[\tau] + \gamma\bar{\mathbb{E}}[Y]$$

$= Y$ (fixed by FG)

$$C = (1-\delta_Y)Y + \delta_Y\bar{\mathbb{E}}[C]$$

$-\frac{(1-\gamma)\alpha}{1-\alpha} \leq 0$

- Game of **substitutes**

  "I expect less spending, so I expect looser policy and spend *more*"

- Friction **increases** effectiveness of FG

  Turns FG literature upside down

Implementability

Proposition: implementable sets

$$\{(\tau, Y) : \tau = \mu_\tau(\gamma, \lambda) Y\}$$

Instrument communication

$$\{(\tau, Y) : \tau = \mu_Y(\gamma, \lambda) Y\}$$

Target communication

attenuation ← $\mu_\tau(\gamma, \lambda) > 1 > \mu_Y(\gamma, \lambda)$ → amplification

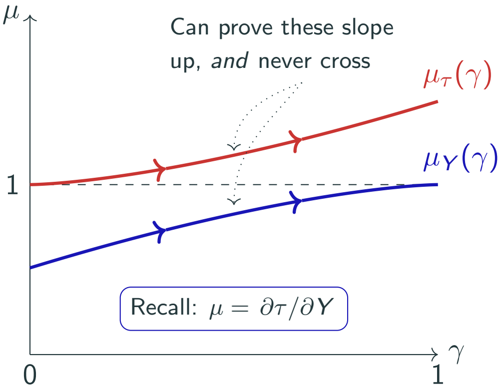
- Friction $\neq$ "everything is dampened"
- TC keeps powder dry

The Role of the GE Feedback

Proposition

$\partial \mu_\tau / \partial \gamma > 0$

$\partial \mu_Y / \partial \gamma > 0$



The Role of the GE Feedback

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$\partial \mu_\tau / \partial \gamma > 0$

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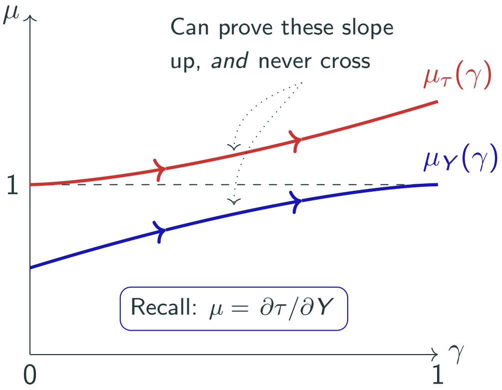
Quick intuition

Distortion from reasoning about what is not announced

High $\gamma \to$ very important to figure out Y, not so much τ



$$\text{as } \gamma \text{ (GE) increases} \Rightarrow \begin{cases} \text{distortion under IC increases} \\ \text{distortion under TC decreases} \end{cases}$$

Main Result

Theorem: optimal communication

There exists a $\hat{\gamma} \in (0,1)$ ("critical GE feedback") such that

- $\gamma < \hat{\gamma}$: optimal to communicate instrument
- $\gamma \geq \hat{\gamma}$: optimal to communicate target

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Additional results in paper:

precise values of optimal message and attained (τ, Y)

variant with Level-k Thinking

Level-k

Generalized Departure from RE

- Misspecified beliefs:

$$\bar{\mathbb{E}}[C] = \lambda C + \sigma\epsilon$$

  where $\lambda, \sigma > 0$ and ϵ is orthogonal to θ

- Nests:
  - under-reaction ($\lambda < 1$): FG literature
  - over-reaction ($\lambda > 1$): Shleifer et al
  - noise or animal spirits ($\sigma > 0$)

Generalized Departure from RE

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- Nests:
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- Optimal policy result goes through
  - intuition: all about limiting the role of $\bar{\mathbb{E}}[C]$
  - i.e., "more thinking = more distortion" result extends

Take-Home Lessons

How to communicate / manage expectations?

- Tilt focus from R path to u, Y targets
  when feedback loops are strong

New perspective on Taylor rules

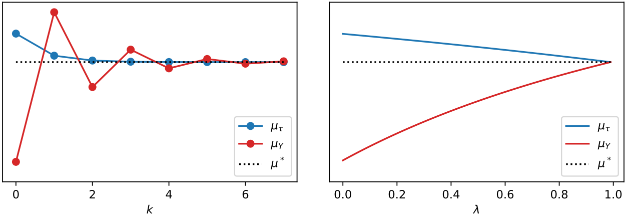
- Traditional: demand vs supply shocks
- Here: arrest bounded rationality or nearly self-fulfilling traps

Extend logic from multiple equil (Mario Draghi) to unique equil

- large multipliers $\rightarrow$ HOB critical $\rightarrow$ "nearly" self-fulfilling $\rightarrow$

Level-k: Similar but Less Sharp

- Instrument comm (games of complements): the same
  - others are less rational ≈ others are less attentive
- Target comm (games of substitutes): a bug
  - distortion changes sign between even and odd k



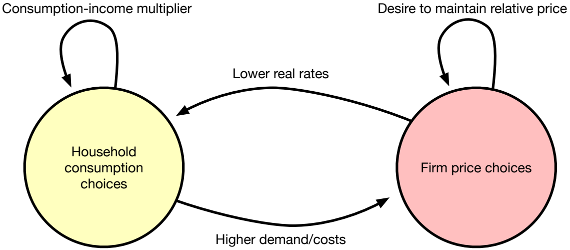
- Our preferred formulation avoids the bug

go back

- Cognitive discounting avoids it too (but confounds PE-GE)

FG: Three GE Feedbacks

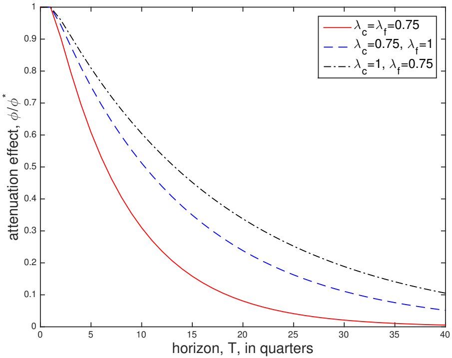
1. Within Dynamic IS: Keynesian cross
2. Within NKPC: dynamic pricing complementarity
3. Across: inflation-spending feedback



- All three: intensify with length of ZLB / horizon of FG

FG: Numerical Illustration

- Textbook NK model, with modest friction ($\lambda = .75$)



- Attenuation by 90% when ZLB last 5 years
- Plus, discontinuity at infinite horizons

go back