Central Bank Communication and Expectations Stabilization

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Motivation

- Transparency and communication emphasized in modern central banking
  - Inflation targeting
  - E.g.: Bank of England, Norges Bank

Goal

Blinder (1998)

- A central bank that is inscrutable gives the markets little or no way to ground these perceptions [about monetary policy] in any underlying reality — thereby opening the door to expectational bubbles that can make the effects of its policies hard to predict.

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- Rational expectations logic underscores importance of systematic component of policy
  - But expectations consistent with policy by assumption

Application

- Simple model of output gap and inflation determination

- Two key informational frictions: Friedman (1968)
  - Central bank cannot observe current state
  - Agents do not have a complete economic model of aggregates
    - Expectations not pinned down

- Explore potential benefits of communicating certain kinds of information about monetary policy regime

Communication Strategies

- Benchmark analysis: no information about policy
  - Policy represents only one of several sources of uncertainty

- Evaluate advantages of:
  - Communicating complete details of the policy rule
  - Communicating the variables upon which policy decisions are condition
  - Communicating the inflation target

Results

- Uncertainty about the state and policy have importance consequences for stabilization policy

- Communicating the systematic component of policy unambiguously improves stabilization

- Announcing an inflation target is not enough to achieve stabilization of expectations
  - One must also announce how the objective will be achieved

Literature

- Learning and policy design
  - Howitt (1992), Bullard and Mitra (2002), Evans and Honkapohja (2003), Preston (2005)
- Transparency
  - Svensson and Faust (2001), Geraats (2005), Morris and Shin (2003)
- Build on
  - Orphanides and Williams (2005), Hellwig (2005) and Walsh (2007)

Model Agents

- Households
- Firms
- Monetary authority
- Fiscal authority

Model Features

- Money or cashless limit
- Monopolistic competition/nominal rigidities
- Incomplete asset markets
- No capital
- Non-rational expectations

Beliefs

Under rational expectations:

1. Agents optimize given beliefs

2. The probabilities they assign to future state variables coincide with the predictions of the model

This paper retains (1) and replaces (2) with

$2'$. Future state variables outside agent's control are forecasted using an econometric model.

Knowledge

- Know own preferences and constraints

- Do not know true economic model determining variables outside their control.

  - E.g. even if $Y_t^i = Y_t^j = Y_t$ in EQ $\nRightarrow$ agents know $Y_t^i = Y_t^j$

- Observe aggregate variables and disturbances

- Forecast variables outside their control using an atheorectical VAR

  - Takes the minimum state variable form

Household Problem

- Maximize

$$\hat{E}^i_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \left[\ln C^i_T - h^i_T \right]$$

subject to the flow budget constraint

$$B^i_t \leq R_{t-1} B^i_{t-1} + W_t h^i_t + P_t \Pi_t - P_t C^i_t$$

  - Consumption decisions made one period in advance
  - Beliefs: a-theoretical VAR of exogenous variables
  - Nests MSV REE

First order conditions

- Euler equation

$$\hat{C}_t^i = \hat{E}_{t-1}^i \left[\hat{C}_{t+1}^i - (i_t - \pi_{t+1}) \right]$$

and the intertemporal budget constraint

$$\hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \hat{C}_T^i = \omega_{t-1}^i + \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \hat{Y}_T^i$$

where

$$\omega_t^i = B_t^i / \bar{Y}$$

Optimal Consumption Rule

- Log-linear approximation provides

$$\hat{C}_t^i = (1-\beta)\,\omega_{t-1}^i + \hat{E}_{t-1}^i \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta)\hat{Y}_T^i - \beta(i_T - \pi_{T+1}) \right]$$

  - Permanent income theory
  - Efficacy of policy: depends on conditional interest rate forecasts

Connection to Euler equation learning

- Assume $\omega_{t-1}^{i} = 0$, quasi difference optimal decision rule

$$\hat{C}_t^i = \hat{E}_{t-1}^i \left[(1-\beta) \hat{Y}_t - \beta \left(\hat{\imath}_t - \hat{E}_t^i \pi_{t+1} \right) \right] + \beta \hat{E}_{t-1}^i C_{t+1}^i$$

- Assuming agents know market clearing conditions

$$\hat{Y}_t = \hat{C}_t = \hat{C}_t^i$$

yields

$$\hat{C}_t^i = \hat{E}_{t-1}^i \left[\hat{C}_{t+1}^i - (i_t - \pi_{t+1}) \right]$$

Optimal Forecast

Firms

- Continuum of firms maximize

$$\hat{E}^j_{t-1} \sum_{T=t}^{\infty} Q_{t,T} P_T \Pi_{j,T}$$

where

$$\Pi_{j,t} = \frac{P_{jt}}{P_t} Y_{j,t} - \frac{W_t}{P_t} h_{jt} - \frac{\psi}{2} \left(\frac{P_{jt}}{P_{jt-1}} - 1 \right)^2$$

  - Prices set one period in advance
  - Rotemberg (1982) pricing

Optimal Pricing Rule

- Log-linear approximation provides

$$\hat{P}_t^i = \hat{P}_{t-1} + \hat{E}_{t-1}^i \sum_{T=t}^{\infty} \beta^{T-t} \xi \left(\hat{s}_T + \hat{\mu}_T \right)$$

where $\xi > 0$; $\hat{s}_t$ marginal costs; and $\hat{\mu}_t$ a cost push shock

Aggregate Dynamics

- Log-linearizing, aggregating and imposing market clearing at time t provides

$$x_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta)x_{T+1} - (i_T - \pi_{T+1} - \hat{r}_T^e)\right]$$

$$\pi_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \xi \left(x_T + \hat{\mu}_T\right)$$

where $x_t = \hat{Y}_t - \hat{Y}_t^e$ and $\int_0^1 \omega_t^i = 0$.

Monetary Authority

- Optimal policy problem:

$$\min E_t \sum_{T=t}^{\infty} \left(\pi_T^2 + \lambda_x x_T^2\right)$$

where $\lambda_x > 0$ and subject to the constraints

$$x_t = E_{t-1}x_{t+1} - E_{t-1}\left(i_t - \pi_{t+1} - r_t^e\right)$$

$$\pi_t = \xi E_{t-1}x_t + \beta E_{t-1}\pi_{t+1} + E_{t-1}\hat{\mu}_t$$

- First order condition

$$E_{t-1}\pi_t = -\frac{\lambda_x}{\xi} E_{t-1}x_t.$$

Implementation

- Central Bank adopts the rule

$$i_t = i_t^* + \phi \left(\hat{E}_{t-1}\pi_t + \frac{\lambda_x}{\xi}\hat{E}_{t-1}x_t \right)$$

where

$$i_t^* = \rho_r r_{t-1}^e + \frac{\rho_\mu \lambda_x + (1-\rho_\mu)\xi}{\xi^2 + \lambda_x(1-\beta\rho_\mu)}\rho_\mu \hat{\mu}_{t-1}$$

  – Assume: r_t^e and $\hat{\mu}_t$ autoregressive process with eigenvalues $0 < \rho_r,\ \rho_\mu < 1$

Alternative Formulations

- Optimal commitment: can do with a rule of the form

$$i_t = \bar{\imath}_t^* + \phi \hat{E}_{t-1} \pi_t$$

  for appropriately chosen $\bar{\imath}_t^*$

- Policy accounting for private learning
  - Complex: Central bank needs to know a lot
  - Gaspar, Smets and Vestin (2005), Molnar and Santoro (2005)

Fiscal Authority

- Zero debt policy
  - Understood by agents
  - No need to forecast taxes

Model Summary

$$x_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta) x_{T+1} - (i_T - \pi_{T+1} - \hat{r}_T^e) \right]$$

$$\pi_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \xi \left(x_T + \hat{\mu}_T \right)$$

$$i_t = i_t^* + \phi \left(\hat{E}_{t-1} \pi_t + \frac{\lambda_x}{\xi} \hat{E}_{t-1} x_t \right)$$

E-Stability

- Beliefs:

$$z_t = a_t + b_t z_{t-1} + \varepsilon_t$$

where $z_t = \{x_t, \pi_t, i_t, r_t^e, \hat{\mu}_t\}$

- Convergence under least-squares learning IFF the associated ODE:

$$\frac{d}{d\tau}(a, b) = T(a, b) - (a, b)$$

is locally stable at the REE of interest.

Learning

- Update their beliefs according to

$$\begin{aligned} \phi_t &= \phi_{t-1} + t^{-1} R_t^{-1} w_{t-1} (z_{t-1} - \phi_{t-1}' w_{t-1})' \\ R_t &= R_{t-1} + t^{-1} (w_{t-1} w_{t-1}' - R_{t-1}) \end{aligned}$$

where $\phi = \left[a_t' \ vec\,(b_t)' \right]'$ and $w_t = \{1, \ z_{t-1}\}$ for $z_t = [x_t \ \pi_t \ i_t \ r_t^e \ \hat{\mu}_t]'$

- Actual dynamics

$$\begin{aligned} z_{t-1} &= T(a_{t-1}, b_{t-1})' w_{t-1} \\ &= T(\phi_{t-1})' w_{t-1} \end{aligned}$$

so that the updating equation can be written as

$$\phi_t = \phi_{t-1} + t^{-1} R_t^{-1} w_{t-1} (T(\phi_{t-1}) - \phi_{t-1})' w_{t-1}$$

Benchmark Property I

- Proposition 1: Under rational expectations the model has a unique bounded equilibrium if and only if $\phi > 1$.
  - Taylor principle

Benchmark Property II

- Proposition 2: Under learning dynamics; no communication; and $\phi > 1$

  1. The rational expectations equilibrium is unstable if

  $$(1+\phi)\xi > \phi(1-\beta)\frac{\lambda_x}{\xi} + \psi(\beta)$$

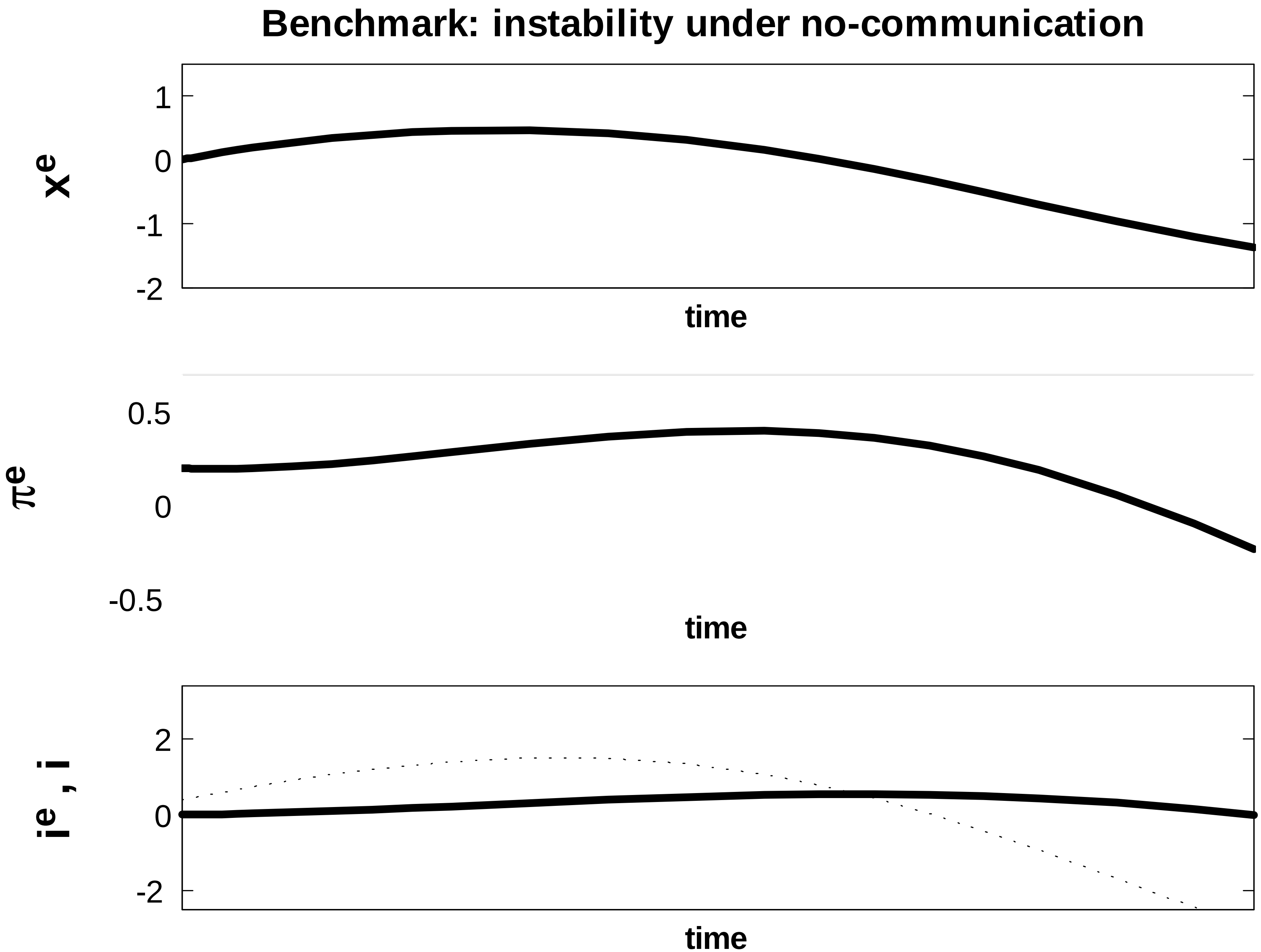
     where $\psi(\beta) > 0$, $\lim_{\beta \to 1} \psi(\beta) = 0$ and $\lim_{\beta \to 0} \psi(\beta) = \infty$. Hence:

  2. If $\beta \to 1$, then the REE is unstable under learning for every ξ and ϕ.

  3. If $\beta \to 0$, then the REE is stable under learning for every ξ and ϕ.

Some Intuition

- Forecast-based instrument rules argued to be desirable
  - Batini and Haldane (1999), Levin et al (2001)
- Not here: real interest rates initially decline with inflation shock
- Aggressive inflation response destabilizing
  - Not true of output
  - Schmitt-Grohe and Uribe (2004, 2005)



Benchmark: instability under no-communication
x^e
1
0
-1
-2
time
π^e
0.5
0
-0.5
time
i^e, i
2
0
-2
time

Recall

$$x_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta) x_{T+1} - (i_T - \pi_{T+1} - \hat{r}_T^e) \right]$$

$$\pi_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \xi \left(x_T + \hat{\mu}_T \right)$$

Sourcing Instability

- Two key informational frictions
  - Central bank imperfectly observes the state of the economy
  - Households and firms have incomplete model
- What is the relative importance of these frictions?

Eliminating Policy Delays

- Suppose the central bank perfectly observe current state

- Can implement the rule

$$i_t = i_t^* + \phi \left(\pi_t + \frac{\lambda_x}{\xi} x_t \right)$$

- Proposition 3: Under learning dynamics and $\phi > 1$ the REE is stable for all parameter values

  - Howitt (1992), Bullard and Mitra (2002), Preston (2005)

Modeling Communication

- Communication affects the form of private agents beliefs
- For example: inflation targeting
  - Central bank communicates average desired outcome for inflation
  - Impose $a_t = 0$ and estimate

$$z_t = b_t z_{t-1} + \varepsilon_t$$

- More efficient forecast

Communication: Strategy I

- Announce the precise policy rule
  - assume perfect credibility and homogeneous beliefs

- Agents know
  - all relevant conditioning variables
  - all relevant coefficients

- Implication: do not need to independently forecast nominal interest rate path

Aggregate Demand under Communication

- Knowledge of policy rule implies

$$x_t = \hat{E}_{t-1} \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta) x_{T+1} - \left(i_T^* + \phi \pi_T + \phi \frac{\lambda_x}{\xi} x_T - \pi_{T+1} - \hat{r}_T^e \right) \right]$$

- Strategy is equivalent to announcing $\left\{ E_{t-1}^{CB} i_T \right\}_{T=t}^{\infty}$
  - E.g.: Reserve Bank of New Zealand, Norges Bank

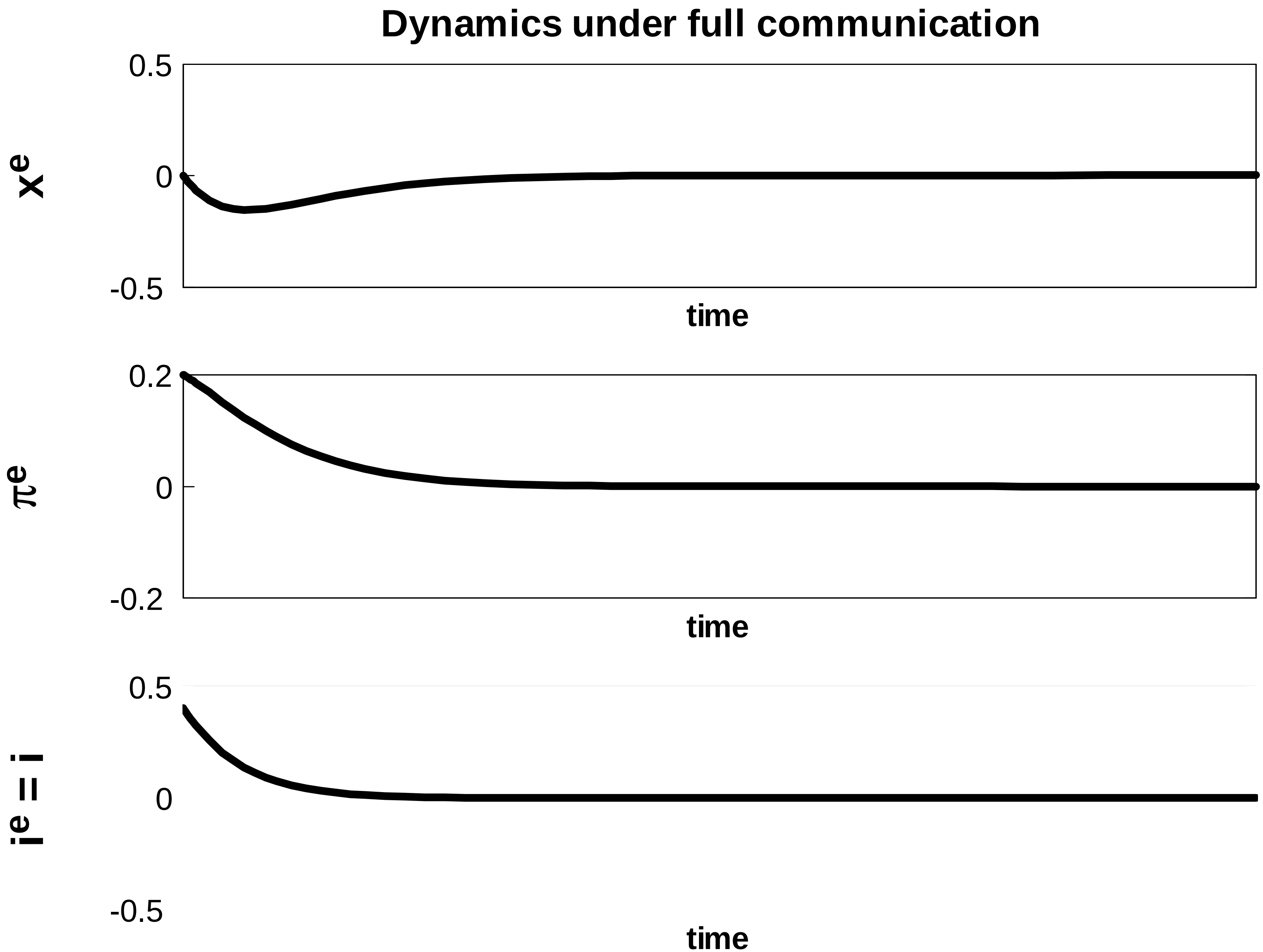
Stability Restored

- Proposition 4: Announcing the interest rate forecast $\left\{E_{t-1}^{CB} i_T\right\}_{T=t}^{\infty}$ or, equivalently, the policy rule

$$i_t = i_t^* + \phi\left(\hat{E}_{t-1}\pi_t + \frac{\lambda_x}{\xi}\hat{E}_{t-1}x_t\right)$$

  implies the REE is stable if $\phi > 1$

  - Procedure has the property that forecasted path of real interest rates rise



Dynamics under full communication
0.5
0
-0.5
x^e
time
0.2
0
-0.2
π^e
time
0.5
0
-0.5
$i^e = i$
time

Communication Strategy II

- Announce only the set of variables upon which interest rate decisions are conditioned

- Interpretation
  - Imperfect credibility
  - Too costly to communicate complexities of the decision process
  - Agents wish to verify announced projections

Verification of Policy

- Agents adopt a two-stage forecasting model

- Estimate the model

$$i_t = \psi_{0,t-1} + \psi_{\pi,t-1} \hat{E}_{t-1} \pi_t + \psi_{x,t-1} \hat{E}_{t-1} x_t + e_t$$

- Then construct forecasts consistent with this model of policy

Communication Strategy II

- Proposition 5: The REE is stable if $\phi > 1$
  - Equivalent to full-information case
  - Estimation uncertainty “small”

Communication Strategy III

- Announce average desired values of the inflation rate
  - E.g.: Reserve Bank of Australia

Communication Strategy III

- Proposition 6:Assume the central bank communicates only the inflation target $\pi^* = 0$ and the associated values for the output gap and nominal interest rates, $x^* = i^* = 0$.

  1. Define $\rho = \max(\rho_u, \rho_r)$ and let $\rho \rightarrow 1$. Then the REE is unstable under learning if conditions of Proposition 2 hold;

  2. Let $\beta \rightarrow 1$. Then the REE is unstable under learning if

$$\xi(\phi + 2\rho) > 2\frac{\phi\lambda_x}{\xi}(1 - \rho) + \tilde{\psi}(\rho),$$

  where $\tilde{\psi}(\rho) > 0$, $\tilde{\psi}(1) = 0$ and $\tilde{\psi}(\infty) = 1$.

Calibration

- Let $\beta = 0.99$, $\theta = 10$, and $\phi = 2$

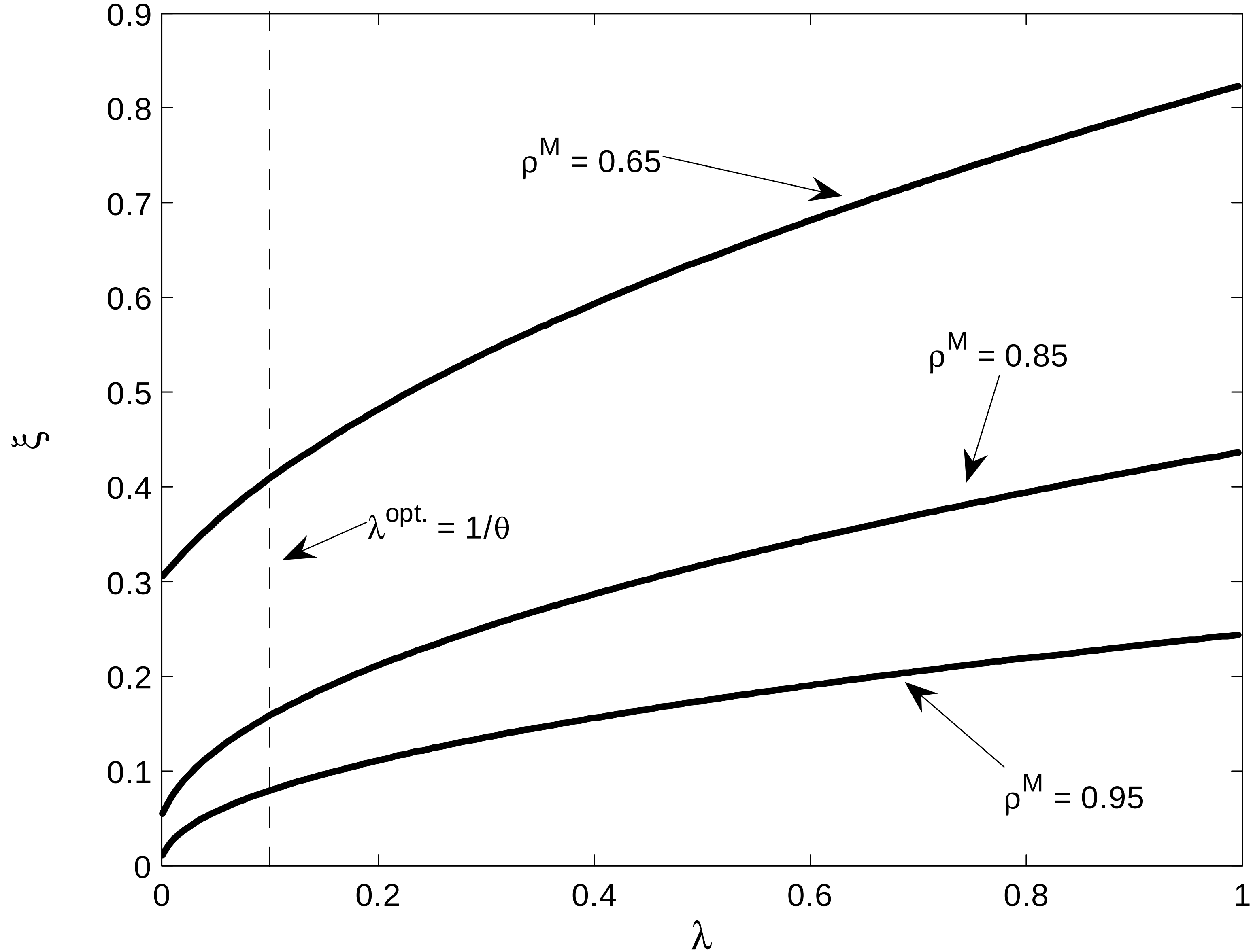


Figure 1: Announcing the target is not enough

The Role of Nominal Rigidities

- Higher degrees of rigidity associated with greater stability

- Prices move less, permitting agents to more easily infer future path of prices

The Value of Communication

- Underscores the importance of rational expectations logic
- Knowing the systematic component of monetary policy decisions central to expectations stabilization
- Not enough to announce objectives: one must also announce how such objectives will be achieved.

Further Insights: Dynamics of Expectations

- Does communication help even in the case of convergence?

- Example: Evolution of beliefs on natural rate coefficients are given by the ODE

$$\dot{\omega}_1 = (J^* - I_3)\,\omega_1$$

where

$$\omega_1 = \begin{pmatrix} \omega_{xr} & \omega_{\pi r} & \omega_{ir} \end{pmatrix}'$$

- Assume initially in steady state. Perturb $\omega_{\pi r}$ to make higher that REE value — equivalent to expectational error in forecasting inflation

  – Compare strategy one and three

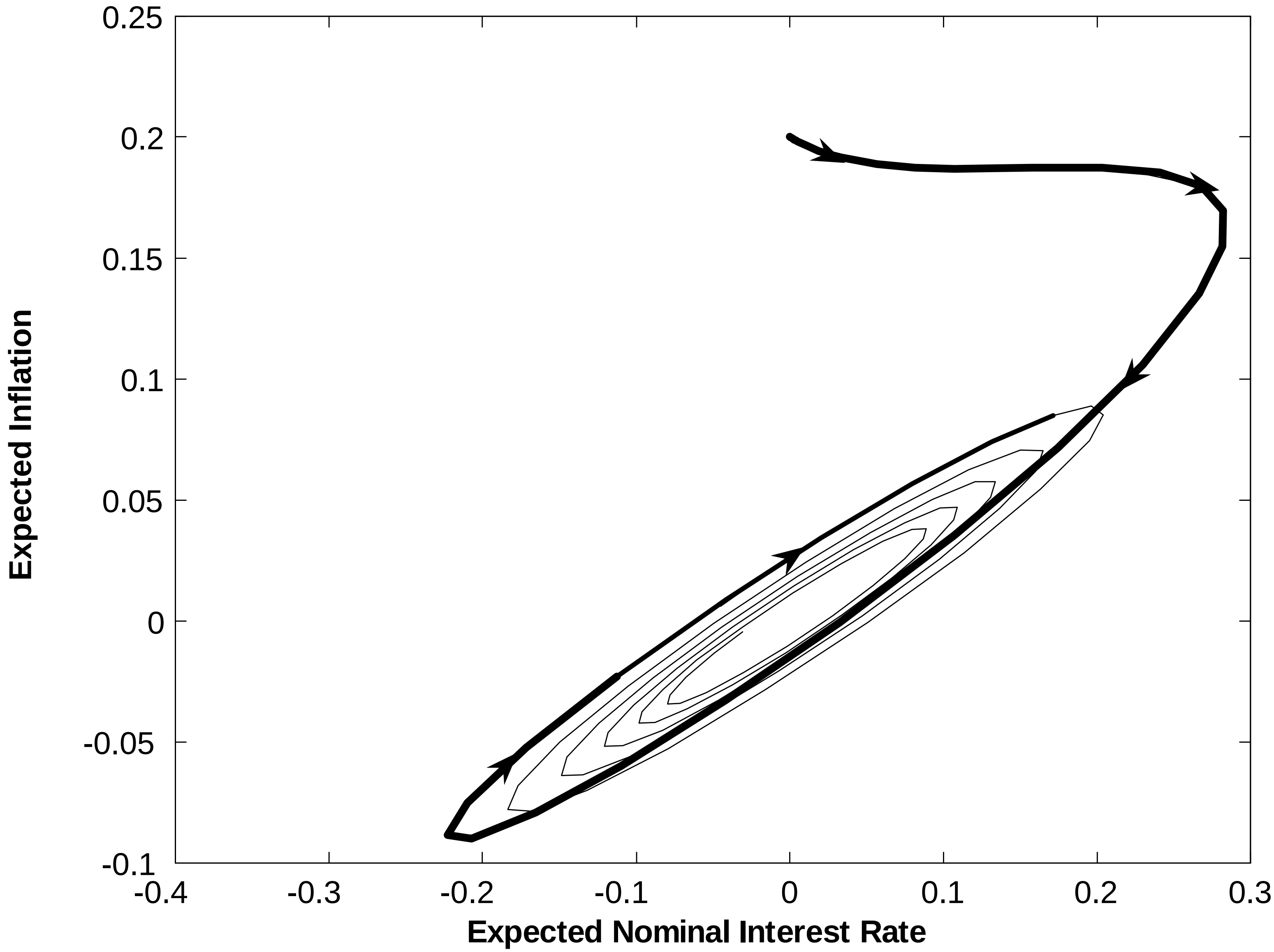


Figure 2: Expectation Dynamics

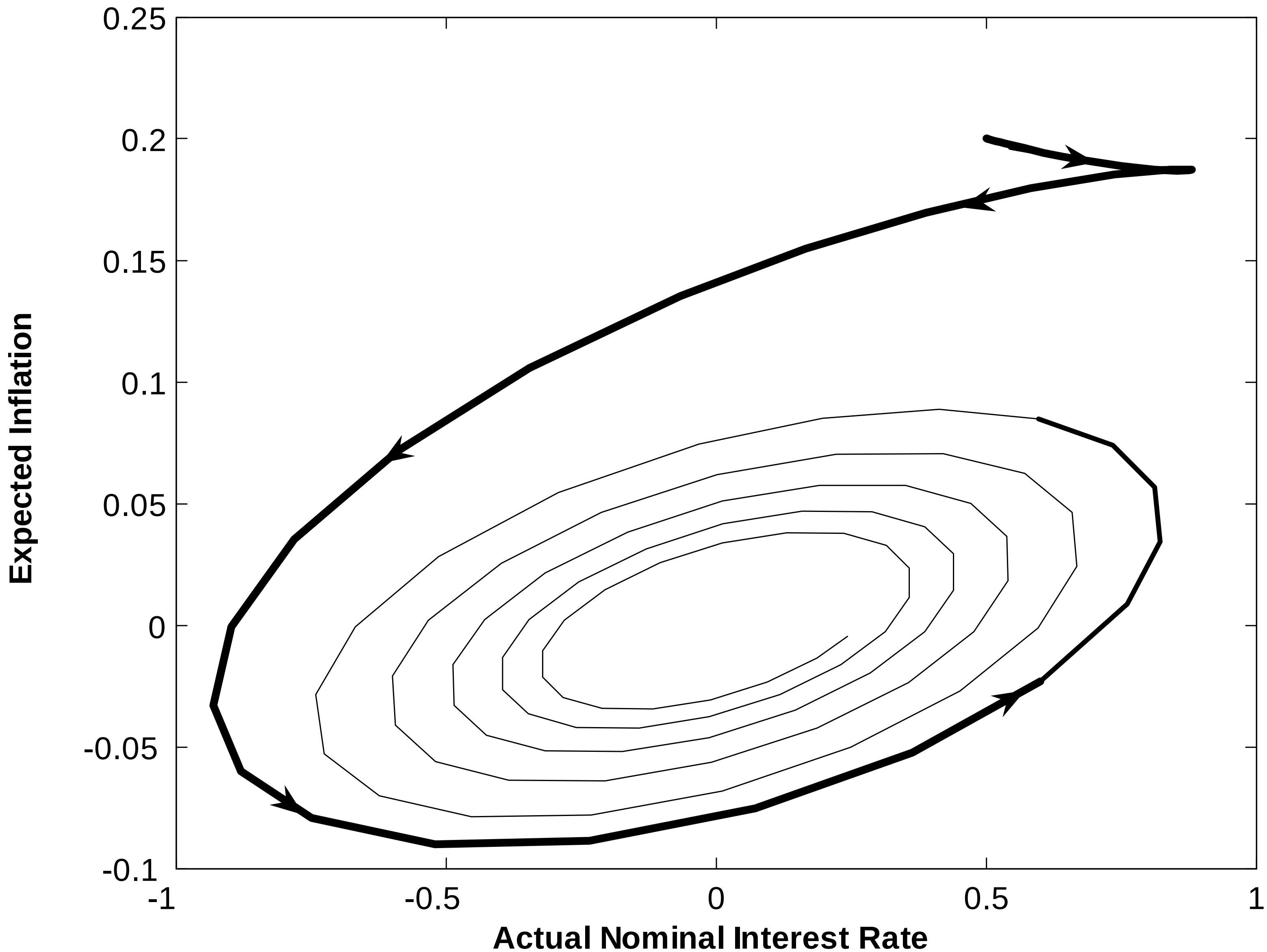


Figure 3: Responding to Expected Inflation

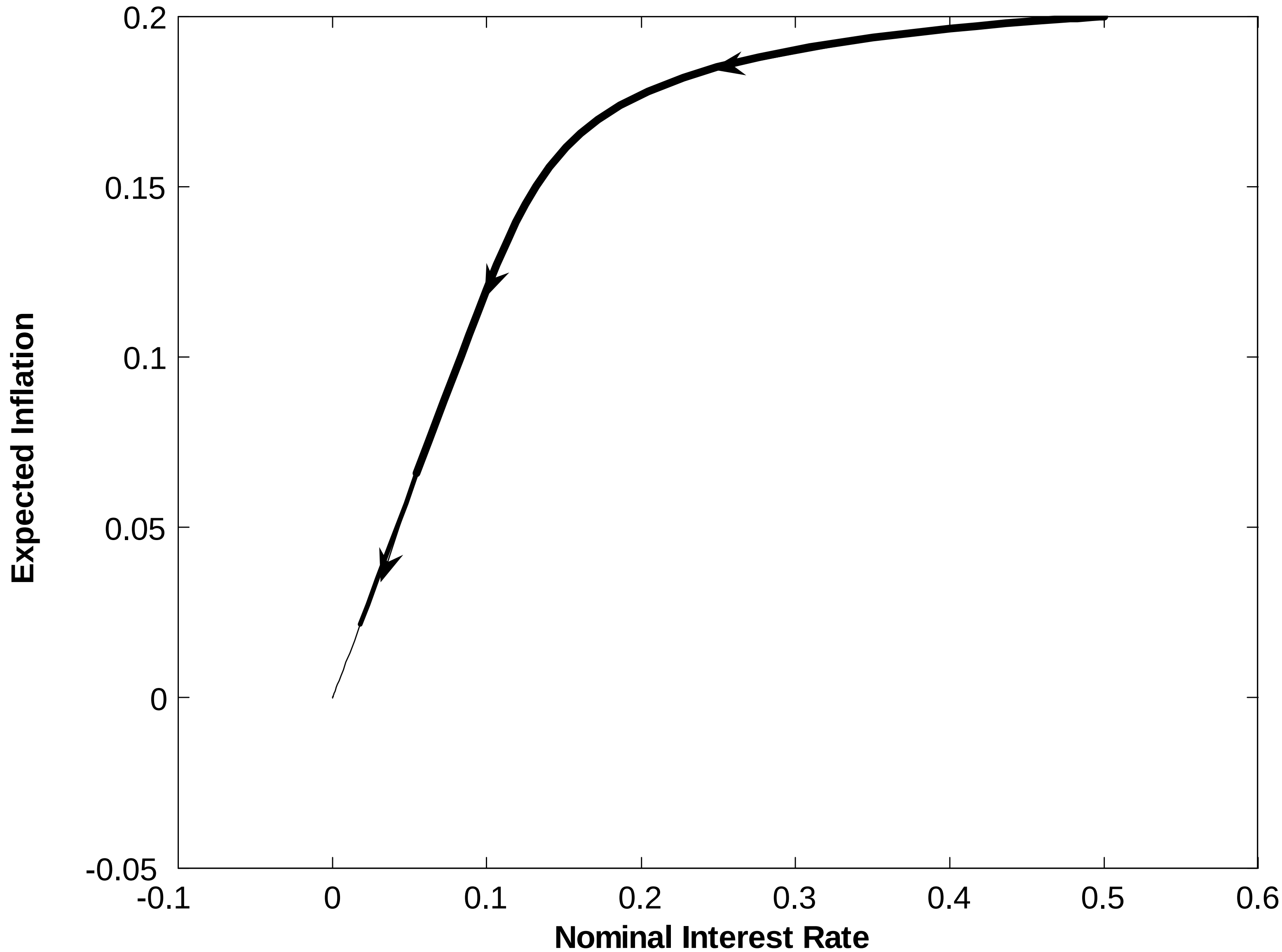


Figure 4: The Benefits of Communication

Benefits of Communication

- Even in the case of convergence communication of systematic component of policy beneficial

- Enables an more accurate forecast of real interest paths, promoting stability
  - Orphanides and Williams (2005)

Robustness

- Purely forward looking model
  - No endogenous propagation mechanisms
  - Lagged information
- Does this matter?
  - Source of knife-edge results
  - Bullard and Mitra (2002), Preston (2004)

Alternative Framework

- Consider the model:

$$\tilde{x}_t = \hat{E}_t \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta)\tilde{x}_{T+1} - (i_T - \pi_{T+1}) + \hat{r}_T^e\right]$$

$$\pi_t = \hat{E}_t \sum_{T=t}^{\infty} \beta^{T-t} \xi \left(\tilde{x}_T + \hat{\mu}_T\right)$$

$$i_t = \rho_i i_{t-1} + (1-\rho_i)\left[i_t^* + \phi\left(\hat{E}_{t-1}\pi_t + \frac{\lambda_x}{\xi}\hat{E}_{t-1}x_t\right)\right]$$

where

$$\tilde{x}_t = x_t - \gamma x_{t-1}.$$

Implications

- Presence of lags aids learning
  - But only narrows region of instability
  - Expectations driven fluctuations still arise for many plausible parameter configurations
- Does timing of information matter?
  - No!
  - Identical results for date t and $t-1$ information under learning and $\rho_i = \gamma = 0$

Conclusion

- Uncertainty about the state and policy have importance consequences for stabilization policy

- Communicating the systematic component of policy unambiguously improves stabilization

- Announcing an inflation target is not enough to achieve stabilization of expectations
  - one must also announce how the objective will be achieved

Commentary

- Market clearing conditions are part of the REE

- Does not deliver optimal decision rule
  - Confuses endogenous decision variables and exogenous state variables
  - The correct distribution with respect to which expectations are taken is induced from the decision problem and properties of exogenous variables
  - In general intertemporal budget constraint will be violated in this formulation

Example

- Optimal consumption forecasts

$$\hat{E}_t^i \hat{C}_{t+1}^i = \frac{\bar{s}}{\bar{C}} \hat{E}_t^i \left(\hat{b}_{t+1} - \pi_{t+1} \right) + \hat{E}_t^i \sum_{T=t+1}^{\infty} \beta^{T-t} \left[\begin{array}{c} (1-\beta) \left(\frac{\bar{Y}}{\bar{C}} \hat{Y}_T - \frac{\bar{s}}{\bar{C}} \hat{s}_T \right) - \beta \left(\tilde{\sigma} - \frac{\bar{s}}{\bar{C}} \right) (i_T - \pi_{T+1}) \\ + \beta (v_T - v_{T+1}) \end{array} \right]$$

not by

$$\hat{E}_t^i \hat{C}_{t+1}^i = \bar{a}_{t-1} + \bar{b}_{t-1} v_t$$