Discussion of Information-Constrained State-Dependent Pricing

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October 17, 2008

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- Can state-dependent pricing behave like time-dependent pricing model?

This Paper

- Menu cost model + cost of learning information about current state.
- Mechanism: Gradual learning about state generates time-dependent price adjustment.
- Extent of state- versus time-dependent pricing depends on parameter values.

This Discussion

- Simple model to illustrate how information problems give rise to different patterns of price adjustment.
  - In the spirit of Mike's model.
  - Based on Burstein, Hellwig, Venki (2008)
- Three comments: key assumptions, parameter values, empirical challenge.

Simple Model of Incomplete Information

$$\min \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \left(p_t - y_t\right)^2 + \kappa \mathbb{I}\left(p_t \neq p_{t-1}\right) \right\}$$

- y_t: underlying state

$$y_t = y_{t-1} + \sigma u_t \ , \ u_t \sim N\left(0, 1\right)$$

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- κ: fixed cost of *fully* learning state y **AND** changing price.
  - $\theta = 0 \Rightarrow y$ known at price adjustment decision (menu cost model).
  - $\theta > 0 \Rightarrow y$ unknown at price adjustment decision.

Model: Firm's decision problem

- Firm states:
  - p: current price
  - m: posterior mean on state y.
  - ϕ: posterior variance on state y.

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- To see why:
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    - $\mathbb{E}\left(p-y\right)^2=\left(m-p\right)^2+\phi$.
  - Current expected loss if price changed:
    - $\mathbb{E}\left(p^*-y\right)^2=0$

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  - Current expected loss if price changed:
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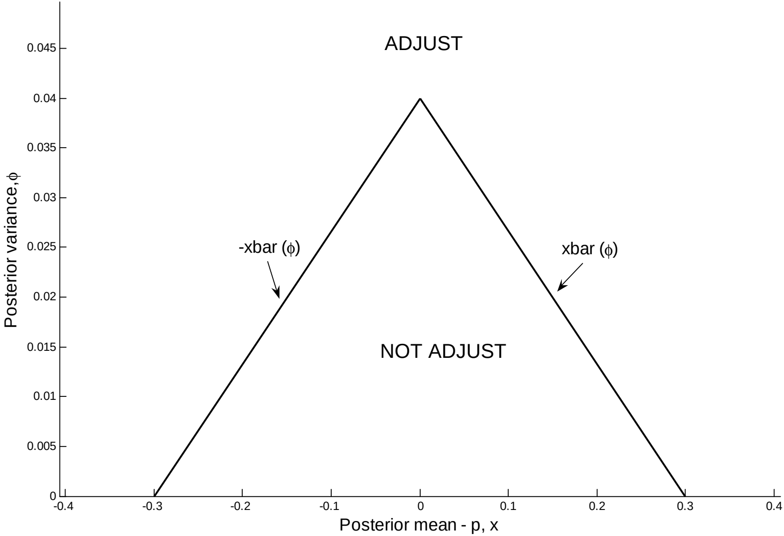
- Re-write state as $x = m - p$ and ϕ.
- Optimal strategy:
  - Pay κ to learn and reprice when x reaches $\bar{x}(\phi)$ or $-\bar{x}(\phi)$.

sS Bands


ADJUST
NOT ADJUST
-xbar (ϕ)
xbar (ϕ)
Posterior variance,ϕ
Posterior mean - p, x
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

Law of motion of state

- If price is changed: $\phi = 0$, $x = 0$.
- If price is unchanged:
  - **Posterior mean:**

$$x' = m' - p$$

$$m' = m + \frac{\phi}{\theta^2} [z - m]$$

  - *Stochastic.*

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  - *Stochastic.*
  - **Posterior variance:**

$$\phi' = \frac{1}{\frac{1}{\theta^2} + \frac{1}{\phi + \sigma^2}}$$

  - Increases *deterministically* over time, converges to $\bar{\phi}$.

Very noisy information

- $\theta \longrightarrow \infty$
- Posterior mean m remains constant

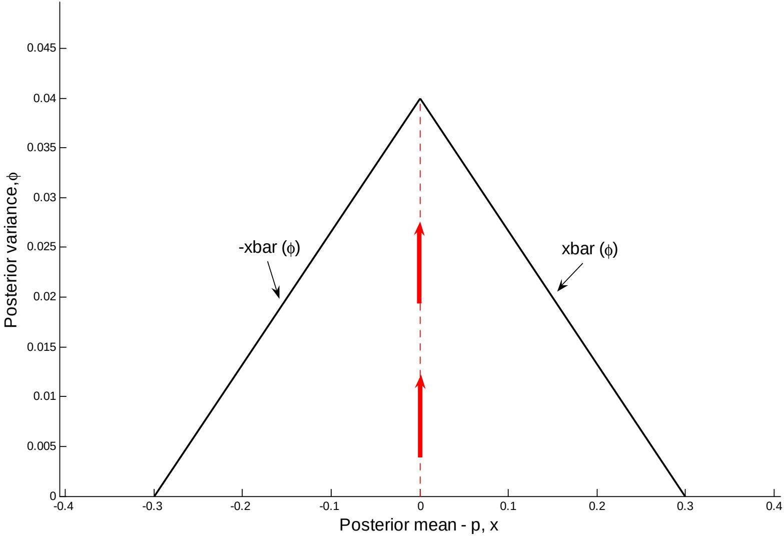
$$x' = 0$$

- Posterior variance increases fast over time.

$$\phi' = \phi + \sigma^2$$

- Time-dependent price adjustment.

Very noisy information, $\theta \longrightarrow \infty$, time dependent adjustment.



Perfect information

- $\theta \longrightarrow 0$
- Posterior mean m equals state

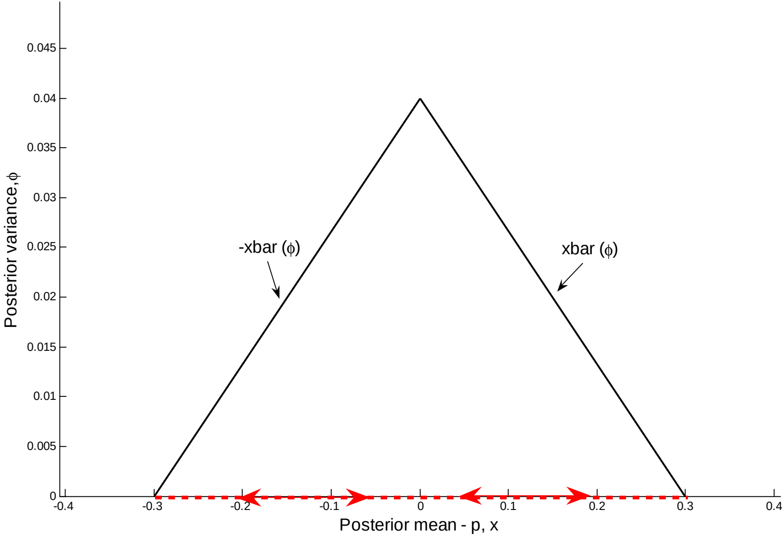
$$x' = y$$

- Posterior variance constant.

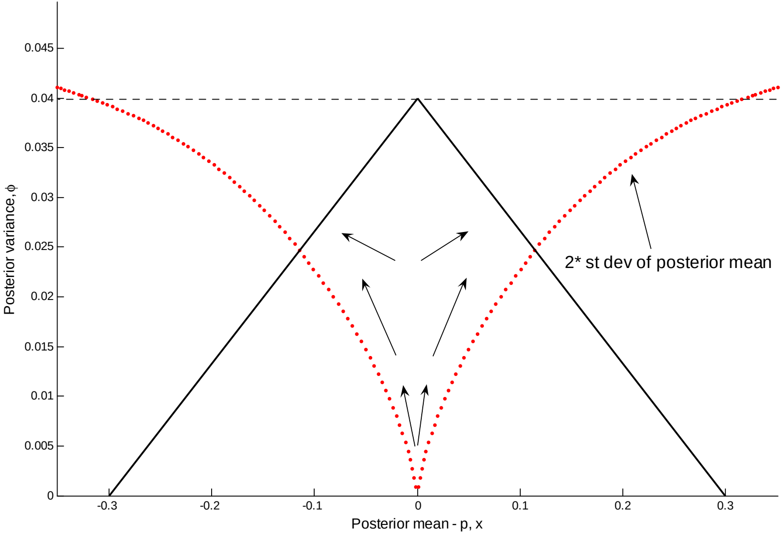
$$\phi' = 0$$

- State-dependent price adjustment.

Perfect information, $\theta \longrightarrow 0$, state-dependent price adjustment



Intermediate θ: Mix of time- and state-dependence.

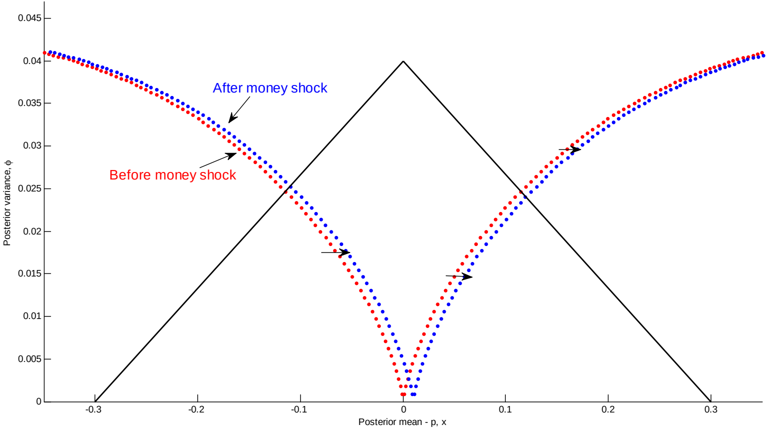


Aggregate monetary shock

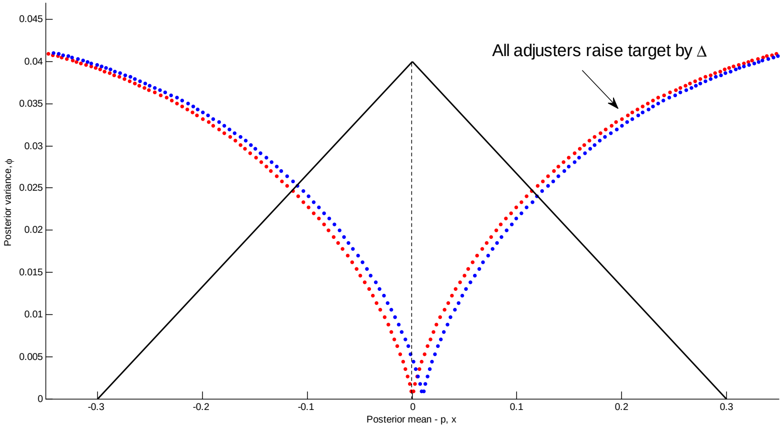
- Assume many firms with independent y and z.

- y increases by Δ for all firms, raises posterior mean x for all firms.

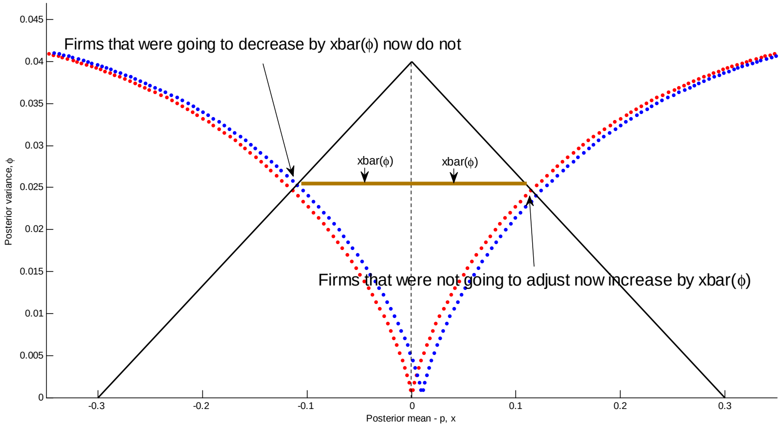
Monetary shock:



Monetary shock: Intensive margin of price adjustment

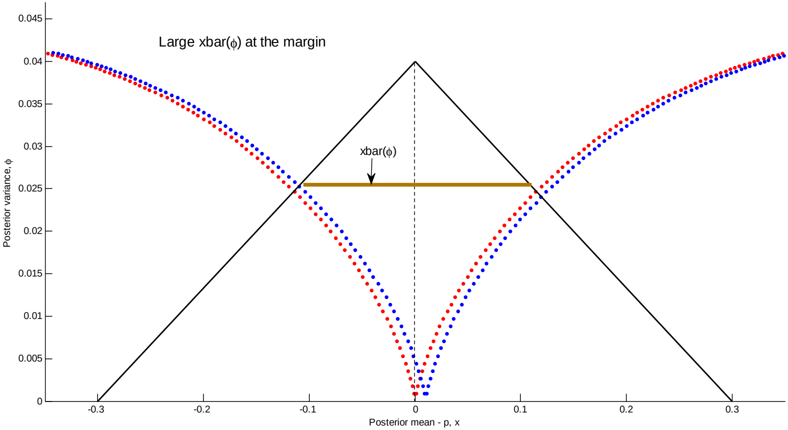


Monetary shock: *Selection effect* in extensive margin



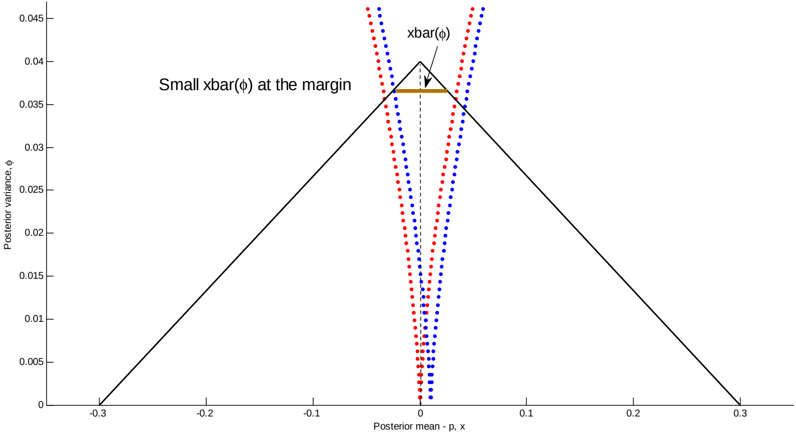
Key: How big is gap $\bar{x}(\phi)$ for marginal adjusters, on average?

Monetary shock: precise information, low θ



Large selection like in state-dependent pricing

Monetary shock: noisy information, high θ.



Small selection like in time-dependent pricing

Monetary shock: selection

- Change in aggregate price on impact:

$$\begin{aligned}\Delta P &= \Delta\text{fraction of adjusters} \\ &\quad +2\Delta\int \bar{x}(\phi)\,\Pi(\bar{x}(\phi),\phi)\,d\phi\end{aligned}$$

- First term: all firms that adjust raise target by Δ.
- Second term (selection): firms that were not going to increase price now do, firms that were going to decrease price now do not.
- How big is gap for marginal adjusters, on average?
  - High θ: small.
  - Low θ: large.

Comment 1: Menu costs versus costs of information

- *Key: firms pay κ to learn underlying state AND change price.*
- Firms choose to adjust based on mean posterior price gap x.
- If firms learn actual price gap $y - p$ small in spite of high expected x, they still change price because κ is sunk.
- Small price changes, mitigates selection in price adjustment.

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- *Alternative assumption: Firms pay κ to learn underlying state, and separately pay F to change price.*
- Firms choose to learn state based on expected gap x and variance ϕ.
- Once y known, firms choose to change price based on **actual** gap $y - p$.
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- *Empirical question: information and repricing costs, relative importance, separate or complementary activities?*

Comment 1: Menu cost versus costs of information

- Small observed price movements (or positive hazard rate for small price gaps) do not help us discriminate between menu costs and information costs.
- Two alternative forms of getting small price movements:
  - Random menu costs, value of manager's time changes over time (Dotsey, King and Wolman).
  - Scale economies in price changes (Midrigan).
- Need other ways to discriminate between menu costs and information costs based on price data.

Comment 2: Calvo vs Taylor

- In my model, firms remember date of price change (state includes ϕ).
- Mike's rational inattention model assumes costly memory.
  - Firms don't remember time of last price change.
  - Time (or ϕ) is not a state variable.
  - Firms draw single signal before deciding whether to pay κ.
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  - Taylor pricing as $\theta \to \infty$.
- Paper emphasizes Calvo versus menu cost model.
- Important distinction is time- versus state- dependent price adjustment.

Comment 3: Parameter values

- Current calibration: small value of σ to match small aggregate price changes (0.7% per quarter).
- Proposed calibration: larger σ to match large idiosyncratic price changes in the data (10% per month).
  - Large shocks reveal state — state-dependent price adjustment.
- Is Calvo still a good approximation with big idiosyncratic shocks?