# Can Supply Shocks Be Inflationary with a Flat Phillips Curve?

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# Introduction

- Two facts:
  1. **The Phillips curve (PC) is fairly flat**
     (Housing bubble, Great Recession, QE 1, 2, 3, 4, ...)
     (Del Negro et al. 2020; Hazell et al. 2020)
  2. **Supply shocks are inflationary**
     (1970s, Post-COVID)
     (Kaenzig 2021; Bunn, Anayi, Bloom et al. 2022)

- Standard models can't account for these two facts
  - Reason: Flat PC $\Longrightarrow$ very rigid price level
    very rigid price level $\Longrightarrow$ no inflation from supply shocks
  - Shortcoming of Calvo, Taylor, Rotemberg, Menu Costs

# What Do We Propose in This Paper?

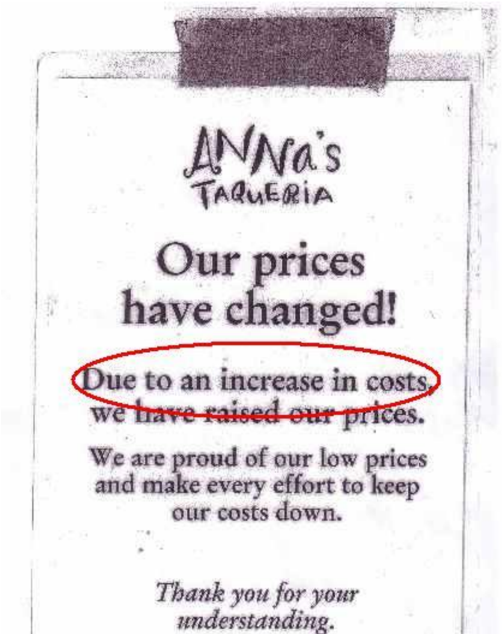
- Data want a model where:
  1. prices are sticky when demand shifts
  2. prices are flexible when supply shifts

  $\longrightarrow$ shock dependence

- Contribution:
  Microfoundation for shock-dependent pricing friction

- Strategic interaction between firms and consumers:
  1. Firms avoid increasing prices when demand increases
  2. But: Firms pass on cost increases to consumers

# Behavior Captured by Our Model



# Aggregate Implications

- Supply shocks make inflation "come alive"
- If central bank raises rates: Creates negative demand shock.

  Two implications:

  1. With flat PC, little or no effect on inflation
  2. This demand shock creates a welfare loss
     (Reason: Demand shock is inefficient)

# Supply Shocks in NK Model

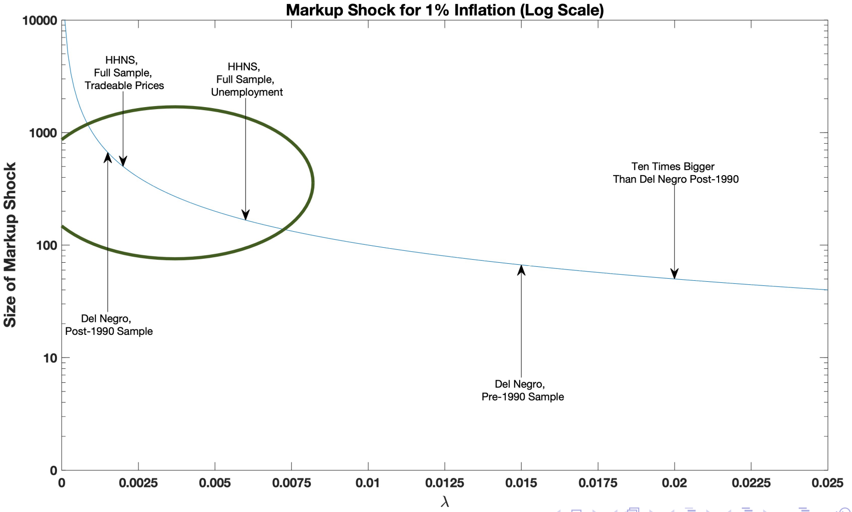
- NK Phillips curve

$$\widehat{\pi}_t = \beta \mathbb{E}_t[\widehat{\pi}_{t+1}] + \kappa \widehat{x}_t + \lambda \hat{z}_t$$

- Estimates for $\kappa$ and $\lambda$ suggest flat PC: $\lambda \in [0.0020, 0.0138]$
  (Del Negro et al. 2020; Hazell et al. 2020)

- Normalization $\nu_t \equiv \lambda \hat{z}_t$:
  - For 1 pp. inc. in $\widehat{\pi}_t$, need $\hat{z}_t \in [72, 500]\%$
    If ss. markup is 12.5%, new desired markup: $[94.0, 575.0]\%$.
    Mmmmh.
  - Why? Calvo implies same degree of stickiness for all shocks

# Alternative Estimates in the Literature, and Likely Orders of Magnitude



# The Model: Some Intuition First

## Environment: Superiorly Informed Firms

Implies strategic interaction with consumers:

- Supply Shocks
  Costs not payoff relevant to consumers
  Firms maximize profits
  **No** strategic concerns
  $\Longrightarrow$ **flexible prices**

- Demand Shocks
  Now, info. about aggregate demand **is** payoff relevant
  But, firms have incentive to misrepresent the state
  Strategic friction
  $\Longrightarrow$ **sticky prices**

# The Model

- Geography: unit mass of islands, and a mainland
- Two periods: the present (short run); the future (long run)
- Agents: households, firms, Central Bank (CB)
- Focus on the present:
  decentralized trading on the islands, sticky prices
  (Future: centralized trading in the mainland, flexible prices)

Presentation: partial equilibrium

# Households

- Unit mass $j \in [0,1]$ on each island, heterogenous information
- Problem:
$$\max \ \mathbb{E}_j \left[ (c_j - c_j^2/2) + \beta \theta C_j \right]$$
$$\text{s.t.} \quad pc_j + QC_j = Income$$

  $\theta$ is demand shock
- Markets:
  - Good $c$ on islands (decentralized): sticky or flex. prices $p$
  - Good $C$ in mainland (centralized): numeraire good
    $Q = \frac{1}{1+i}$ is set by CB, Taylor rule

# Firms and Supply Shock

- Each firm a monopolist on an island
- Marginal cost $z$ (supply shock)
- Sets price $p$

# Information

- Aggregate state: $s = \{\theta, z\}$
- Households:
  - On each island: fraction $\alpha$ informed, fraction $1 - \alpha$ uninformed
  - Distribution of $\alpha$ over islands: $F(\alpha)$
- Firms: informed

# Supply Shocks Only

- State $s = \{1, z\}$, $\theta$ fixed at 1
- DEFINE: Flexible price $p_z$: profit max. ($p_z = \frac{1+z}{2}$)

**Proposition**

*For any $\alpha$, firms post the flexible price $p_z$.*

- When costs fall: Prices $\downarrow$
  When cost increase: Prices $\uparrow \Rightarrow$ demand $\downarrow$
  but this is necessary due to the higher costs.

# Intuition

- Simple and plain profit maximization
- Costs not payoff relevant for consumers
- From firm's point of view:
  irrelevant if consumers know costs or not
  - (in PBE, consumers will infer costs, firms "enjoy" credibility to adjust prices and hence consumers "tolerate" price increases)

# Demand Shocks Only

- State $s = \{\theta, z_0\}$, $z_0$ fixed
- DEFINE: Flexible price $p_s$: profit max. when $\theta$ is known
  Sticky price $p_0$: profit max. when no shock ($\theta = 1$)

**Proposition**

*There is $\overline{\alpha}$ such that:*

- *if $\alpha \geq \overline{\alpha}$: firms post the flexible price ($p = p_s$)*
- *if $\alpha < \overline{\alpha}$: firms post the sticky price ($p = p_0$)*

- Cutoff for price adjustment: fraction of informed consumers

# Intuition

- Strategic friction:
  Firm's incentives to misrepresent the state
  - If can ↑ prices credibly, consumers would spend more
    But, rational consumers understand firm's incentives
    And thus price increases are not necessarily credible

- IC constraint (2 states: Low and High demand shock):
  When state is Low, firm will post $p_L$ if:

$$\Pi(p_L, L) \geq \alpha\Pi(p_H, L) + (1-\alpha)\Pi(p_H, H)$$

  High $\alpha$: becomes slack

- (Consumers "wonder" if price increase is "justified", price increases "antagonize" consumers)

# Both Shocks

- State: $s = \{\theta, z\}$

### Proposition

*There is $\overline{\alpha}$ such that if $\alpha < \overline{\alpha}$, the Phillips curve can be written:*

$$\widehat{\pi}_t = \kappa \widehat{x}_t + \hat{z}_t$$

*where hats denote percentage deviations from steady state, and $\widehat{x}_t$ is the output gap.*

- **Now $\hat{z}_t$ moves $\widehat{\pi}_t$ one-to-one**
- Firms post price $p_{0z} = \frac{1+z}{2}$: demand sticky but supply flexible.

# A "Theory" of Cost-Push Shocks

- NK model:
  - Phillips curve in terms of output: $\widehat{\pi}_t = \kappa \widehat{y}_t - \kappa \hat{a}_t$
  - In terms of output gap: $\widehat{\pi}_t = \kappa(\widehat{y}_t - \hat{a}_t) \underbrace{-\kappa \hat{a}_t + \kappa \hat{a}_t}_{=0} = \kappa \widehat{x}_t$
  - Finally: $\widehat{\pi}_t = \kappa \widehat{x}_t$

    Need to appeal to another shock: $\widehat{\pi}_t = \kappa \widehat{x}_t + \hat{\nu}_t$
- In our model, productivity shocks **show up as cost push**:

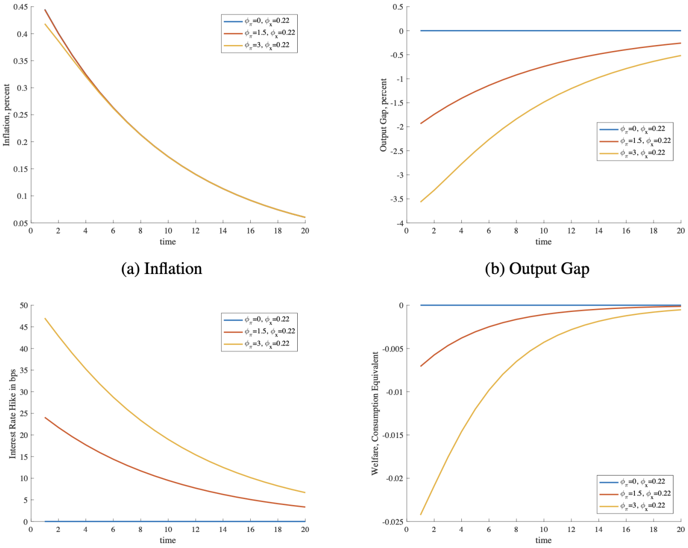
$$\widehat{\pi}_t = \kappa \widehat{x}_t + \hat{a}_t$$

- REASON: Supply shocks don't generate output gaps
  - Output gaps driven only by demand

    Hence model does not need "non-structural" shocks

    (CHARI, KEHOW, MCGRATTAN 2009 CRITIQUE)

# Aggregate Implications: Supply Shock




(a) Inflation

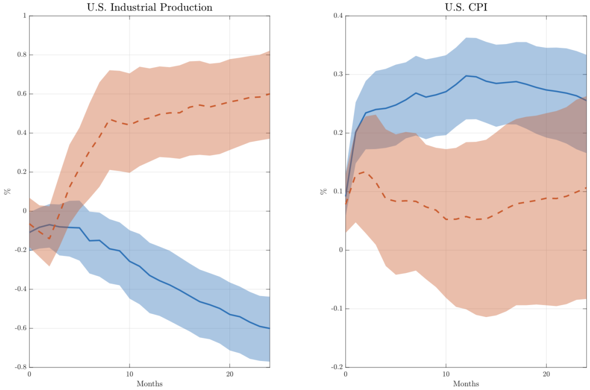
(b) Output Gap

(c) Interest Rate

(d) Welfare (CE)

# Empirical Evidence: VARs with External Instruments

Figure: Effects of Supply Versus Demand Shock




Blue: Supply; Orange: Demand

# Take Away: Shock Dependence

- Types of pricing frictions:
  1. Time dependent
  2. State dependent
  3. ... Shock dependent?
- Ours is <u>one</u> candidate microfoundation
- Explains why inflation rises rapidly when supply disruptions arise