Can Supply Shocks Be Inflationary with a Flat Phillips Curve?

Jean-Paul L'Huillier Gregory Phelan

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Introduction

- Two facts:
  1. **The Phillips curve (PC) is very 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, now)
     (Kaenzig 2021; Bunn, Anayi, Bloom et al. 2022)

- Standard models can't account for these two facts
  - Reason: Flat PC $\Longrightarrow$ no inflation from supply shocks

What Do We Propose in This Paper?

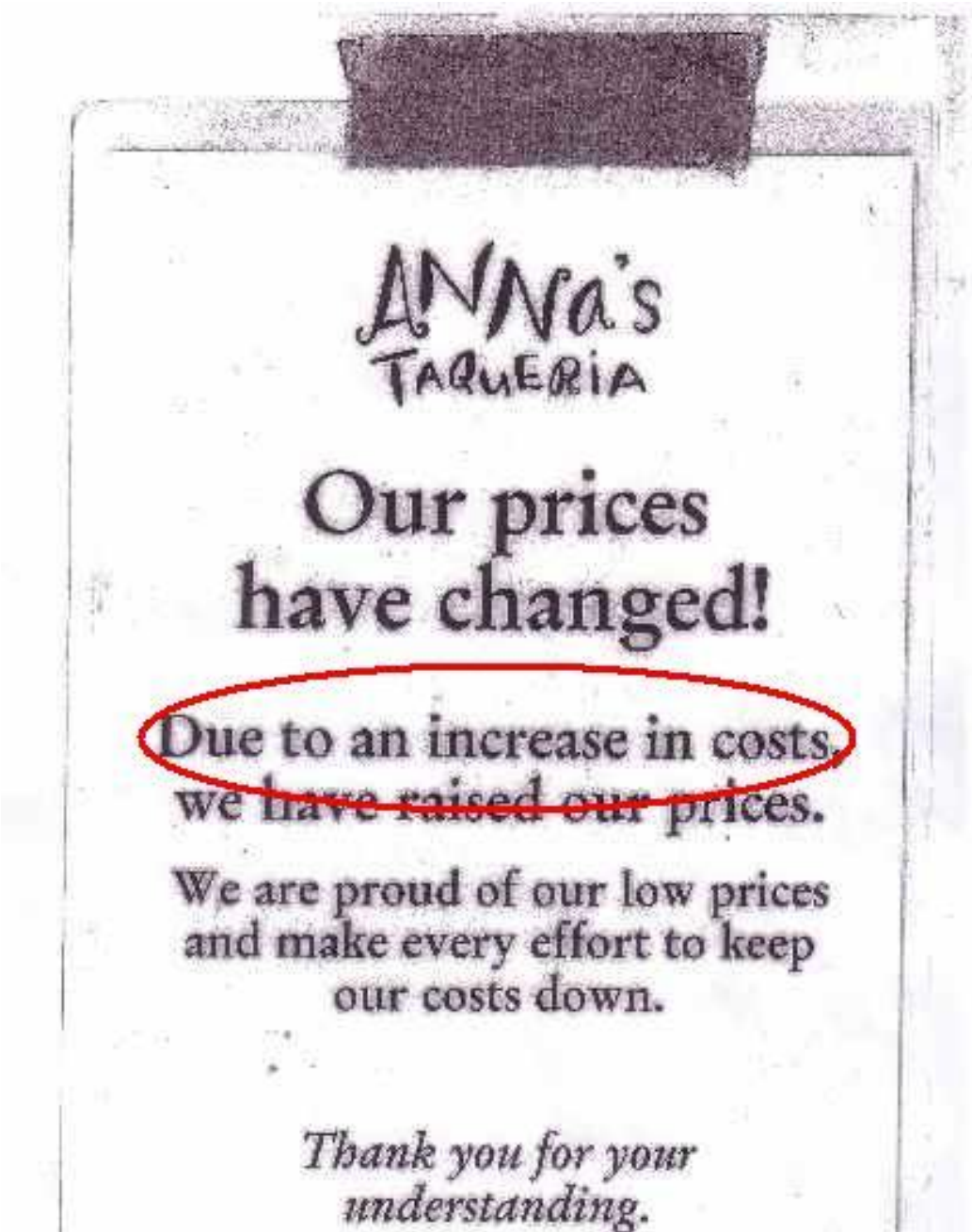
- Data want a model where:
  1. prices are sticky when demand shifts
  2. prices are flexible when supply shifts

  $\longrightarrow$ 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



Phillips Curves: NK Model, and Our Model

- PC in the literature:

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

- Actual NK PC:

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

Notice:

1. Given estimates of κ and λ, $\widehat{z}_t$ is too big
   $\lambda \approx 0.0020$, so $\widehat{z} = 500\%$ for 1% inflation,
   $\widehat{z} = 2500\%$ for 5% inflation
2. $\lambda < 1$ implies stickiness with respect to $\widehat{z}_t$ (Calvo)
   This leads to price dispersion and inflation-output tradeoff

Phillips Curves: NK Model, and Our Model

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- Our PC:

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

Implies:

1. No coefficient in front of $\widehat{z}_t$! (Or, $\lambda = 1$)
   $\widehat{z}_t$ is of same order of magnitude as $\widehat{\pi}_t$
2. Price level *flexibly* adjusts to $\widehat{z}_t$. No price dispersion.
   No inflation-output tradeoff

Supply Shocks in NK Model

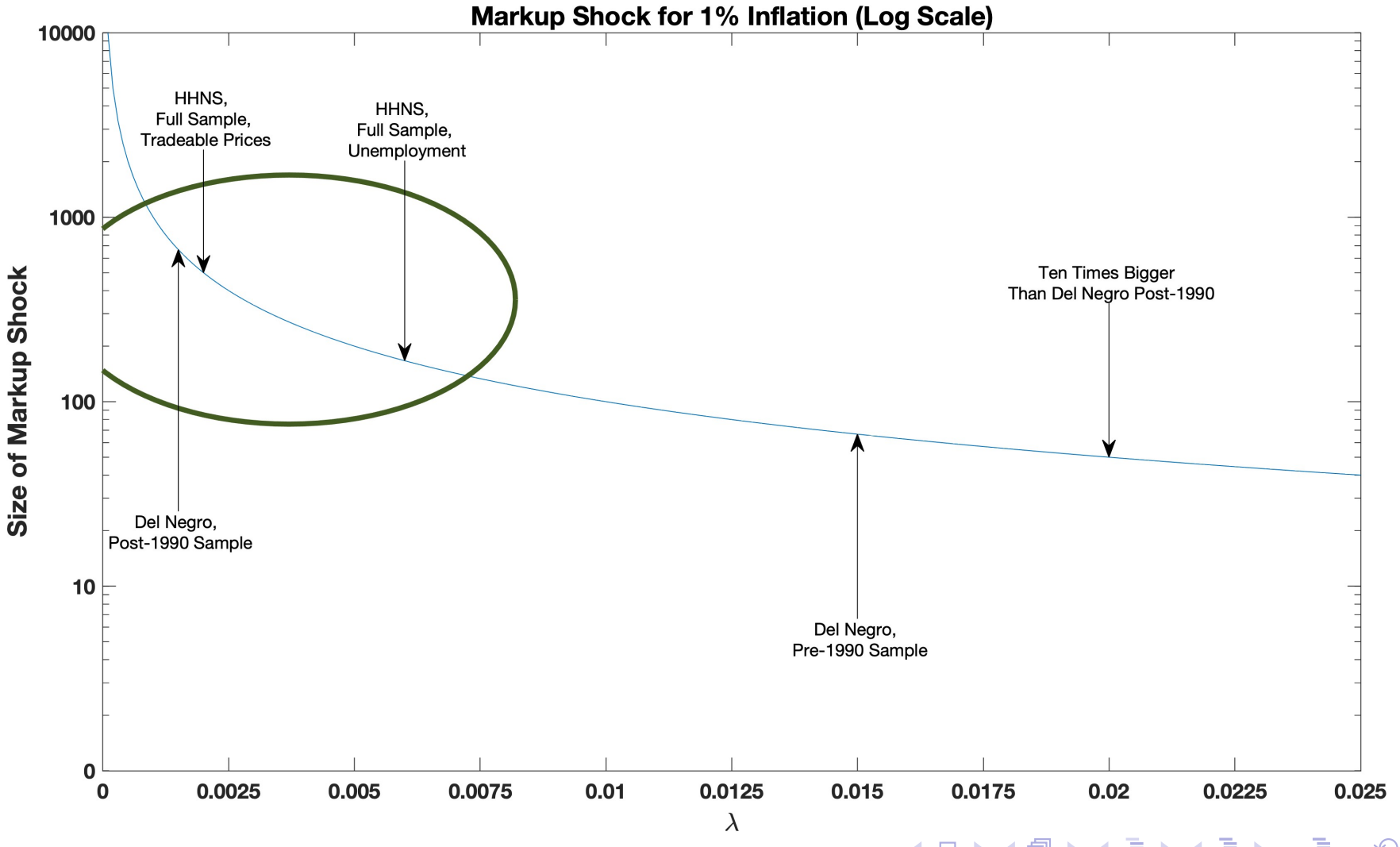
- NK Phillips curve

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

- Estimates for both κ and λ suggest pretty flat PC: $\lambda = 0.0020$
  (Del Negro et al. 2020; Hazell et al. 2020)

- Normalization $\nu_t \equiv \lambda \widehat{z}_t$:
  - For 1% inc. in $\widehat{\pi}_t$, need $\widehat{z}_t = 500\%$
    If ss. markup is 12.5%, desired markup increases to 75.0%.
    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

Key Feature of Goods Market:

- The price is a "signal", a suggestion of how much to spend
  - Two central ideas:
    1. Firms have superior information
    2. Firms carefully consider pricing strategies
  - Leads to strategic firm-consumer interaction

    (Hall & Hitch 1939; Blinder 1991; Rotemberg 2005)

- **Here:** Firms have superior information about aggregates
  - Demand and supply shocks

- **Firm incentives** are the source of the pricing friction

Demand and Supply Shock: Incentives of the Firm

Demand Shock

- **Strategic friction**
- Why?
  Incentive to stimulate demand by posting higher price
  Price increases not always credible $\Rightarrow$ **stickiness**
  (same as L'Huillier (2020), L'Huillier and Zame (2022))

Supply Shock

- **No strategic friction**
- Why?
  Shock not payoff-relevant to consumers!
  Whether or not consumers know costs, **firms change 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:

$$\max \ \mathbb{E}_j \left[(c_j - c_j^2/2) + \beta\theta C_j \right]$$

$$\text{s.t.} \quad pc_j + QC_j = Income$$

  θ 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 α informed, fraction $1 - \alpha$ uninformed
  - Distribution of α over islands: $F(\alpha)$
- Firms: informed

Demand Shocks Only

- State $s = \{\theta, z_0\}$, z_0 fixed

- DEFINE: Flexible price p_s: profit max. when θ 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 ($p = p_0$)*

- Intuition: For high enough fraction of informed consumers, the flexible price is credible.
  Notice: If $\alpha < \overline{\alpha}$, price $\uparrow \Rightarrow$ demand $\downarrow$. Bad idea.

Gist of the Proof (Two States Case)

When state is Low, firm will post p_L if:

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

Notice that $\Pi(p_H, H) > \Pi(p_L, L) > \Pi(p_H, L)$. So:

1. This cannot be satisfied for low α.
2. But if α is high enough, this constraint becomes slack.

Cutoff $\overline{\alpha}$ is obtained from:

$$\Pi(p_L, L) = \overline{\alpha}\Pi(p_H, L) + (1 - \overline{\alpha})\Pi(p_H, H)$$

Supply Shocks Only

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

Proposition

For any α, the flexible price p_z is consistent with a PBE.

- Intuition: z is not payoff-relevant to consumers. No incentive to stimulate demand.
  Proof: No firm IC constraint.
  Notice: Price $\uparrow \Rightarrow$ demand $\downarrow$, but necessary due to costs.

Both Shocks

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

Proposition

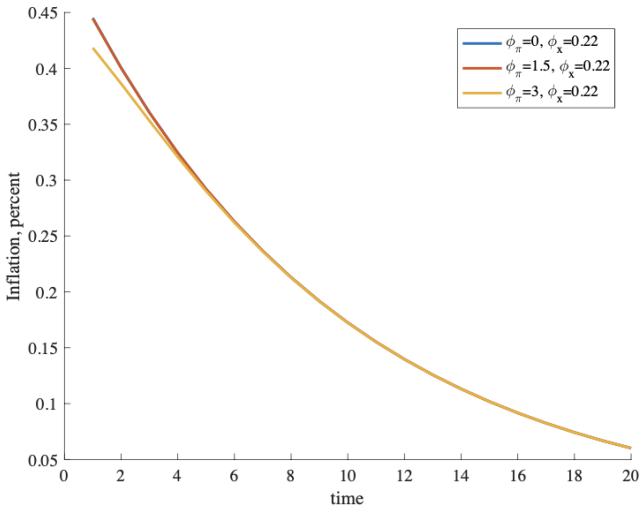
There is $\overline{\overline{\alpha}}$ such that if $\alpha < \overline{\overline{\alpha}}$, the Phillips curve can be written:

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

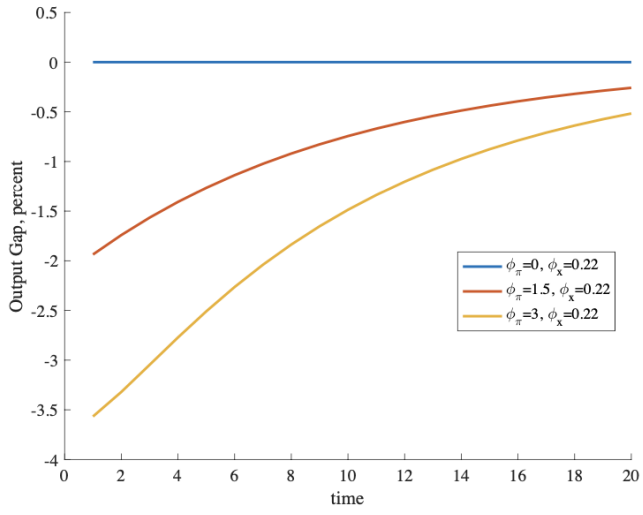
where hats denote percentage deviations from steady state, and $\widehat{x}_t$ is the output gap.

- Firms post price $p_{0z} = \frac{1+z}{2}$: demand-sticky but supply-flexible.

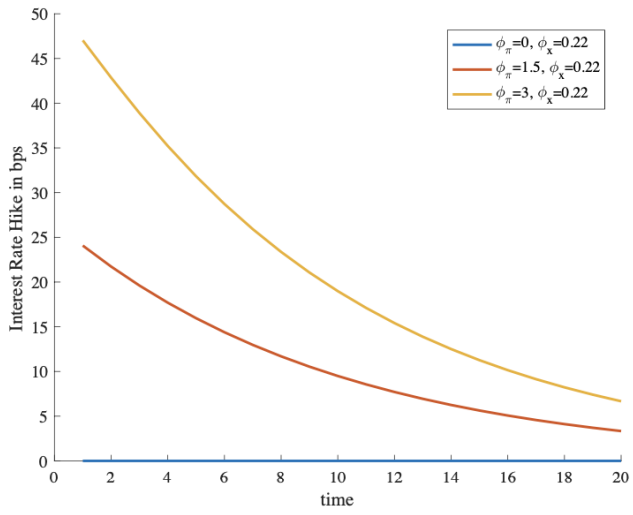
Aggregate Implications: Supply Shock



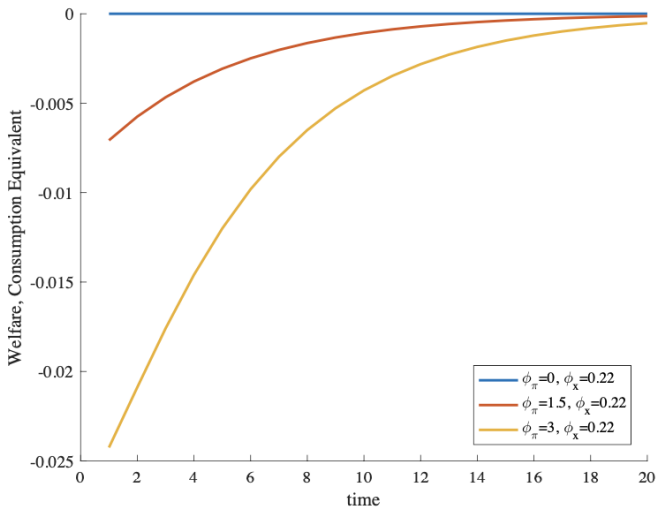
(a) Inflation



(b) Output Gap



(c) Interest Rate



(d) Welfare (CE)

Take Away: Shock Dependence

- Types of pricing frictions:
  1. Time dependent
  2. State dependent
  3. ... Shock dependent?

- Ours is one candidate microfoundation

- Demand Shocks $\Rightarrow$ Firm Incentives $\Rightarrow$ Strategic Friction
  $\Longrightarrow$ **stickiness**
  Supply Shocks $\Rightarrow$ Firm Incentives $\Rightarrow$ No Strategic Friction
  $\Longrightarrow$ **flexibility**