

Micro and Macro Cost-Price Dynamics in Normal Times and During Inflation Surges

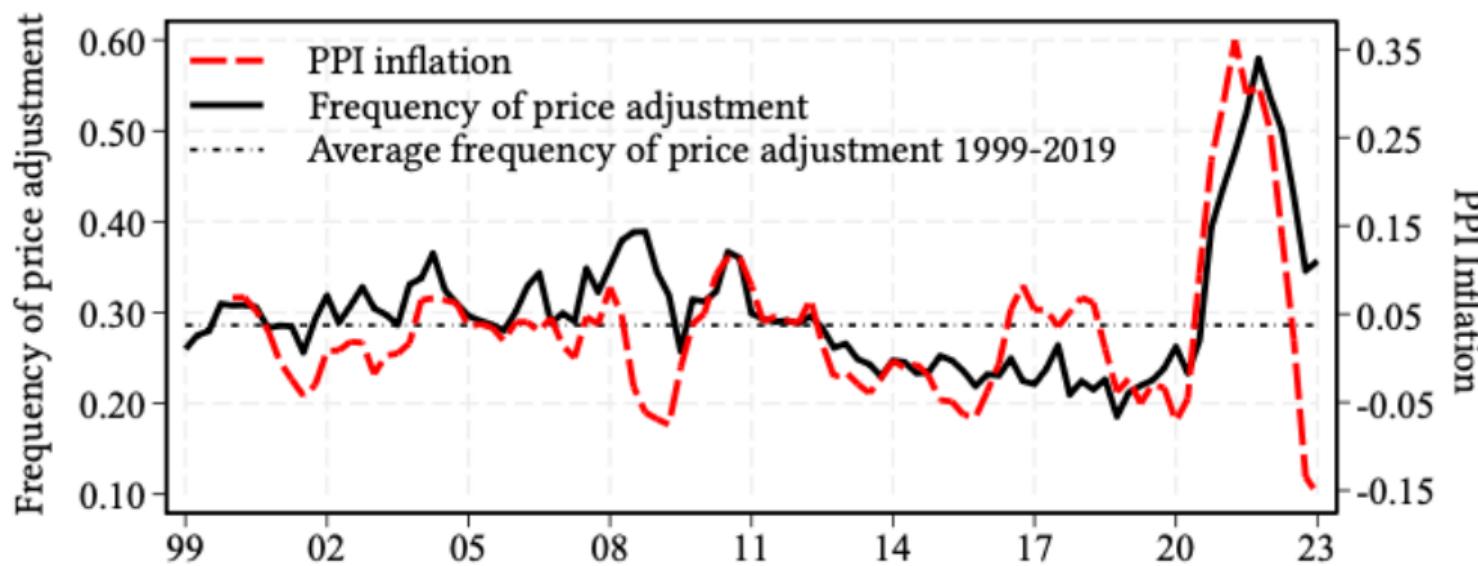
Luca Gagliardone Mark Gertler Simone Lenzu Joris Tielen

Callum Jones
Federal Reserve Board
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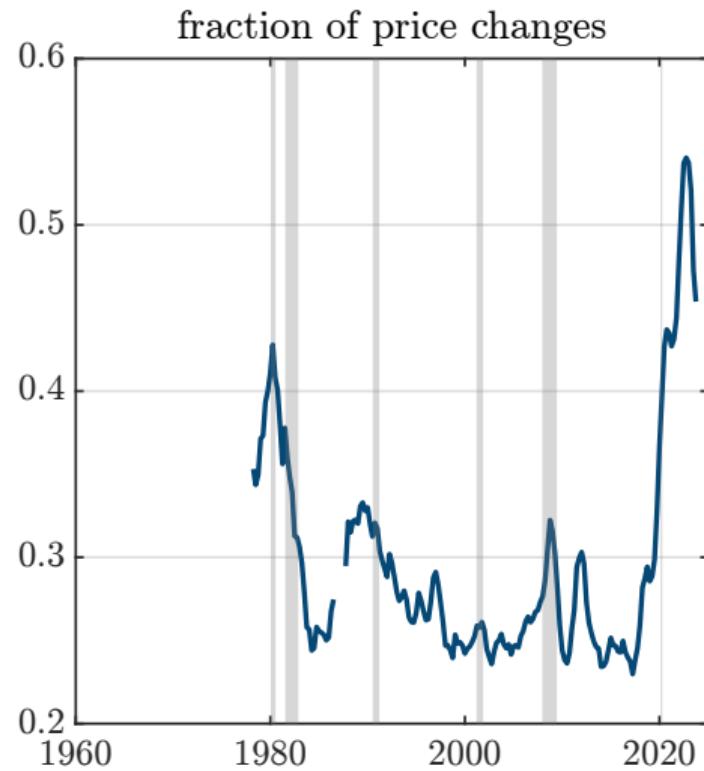
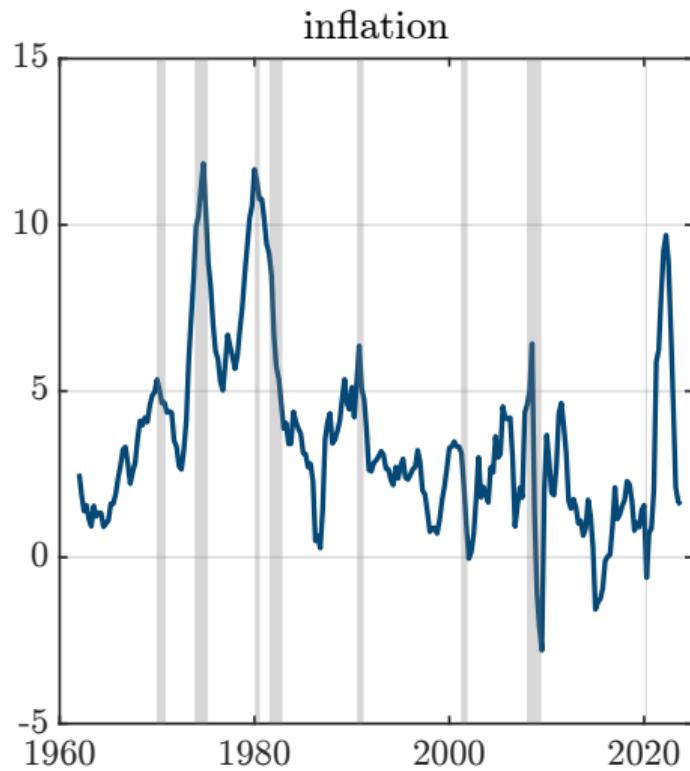
Inflation Surge & Price Adjustment Frequency

In Belgian manufacturing data, both aggregate inflation and the frequency of price adjustments were low and steady for two decades, then spiked during the 2021–2022 inflation surge

Figure 1: Aggregate inflation and frequency of price adjustment



US Data - CPI inflation



Motivation

How do firms' price-setting behaviors drive aggregate inflation dynamics in different environments?

Can standard pricing models (time-dependent vs. state-dependent) explain both "normal" times and sudden inflation bursts?

- ▶ **Time-dependent models (Calvo, Taylor):** Prices change at a fixed probability or interval, independent of economic conditions
- ▶ **State-dependent models (Menu costs):** Firms adjust prices in response to sufficiently large shocks; both the likelihood and size of price changes depend on the state (price misalignment)
- ▶ The recent inflation surge, and widespread / frequent price changes suggestive of state-dependent pricing

Theoretical Framework: Price Gaps and Pricing Behavior

Price Gap (x): difference between optimal frictionless price and its current price

Model Setup: A menu-cost model à la Nakamura & Steinsson (2010) with idiosyncratic cost shocks:

- ▶ Firms face a fixed cost to adjust price. They adjust when the price gap $|x|$ is large enough to justify the cost
- ▶ Time-dependent Calvo model is nested as a special case (menu cost $\rightarrow \infty$)
- ▶ Model yields expressions linking **extensive margin** (adjustment probability) and **intensive margin** (magnitude of Δp) to the price gap

Key Predictions:

- ▶ Small shocks (small $|x|$): infrequent adjustments, linear relationship between expected price change and gap (Calvo-like)
- ▶ Large shocks (large $|x|$): increased adjustment frequency and larger price changes, leading to nonlinear (convex) pass-through of costs to prices

Data and Empirical Strategy

Microdata: Administrative quarterly data on Belgian manuf firms (1999–2023)

- ▶ Firm-level price indices (output prices) and production costs (labor, intermediate inputs)
- ▶ Competitors' price indices by industry, to capture industry-wide pricing environment

Constructing Price Gaps: For each firm f in quarter t , compute target price assuming a constant desired markup over marginal cost and competitors' prices

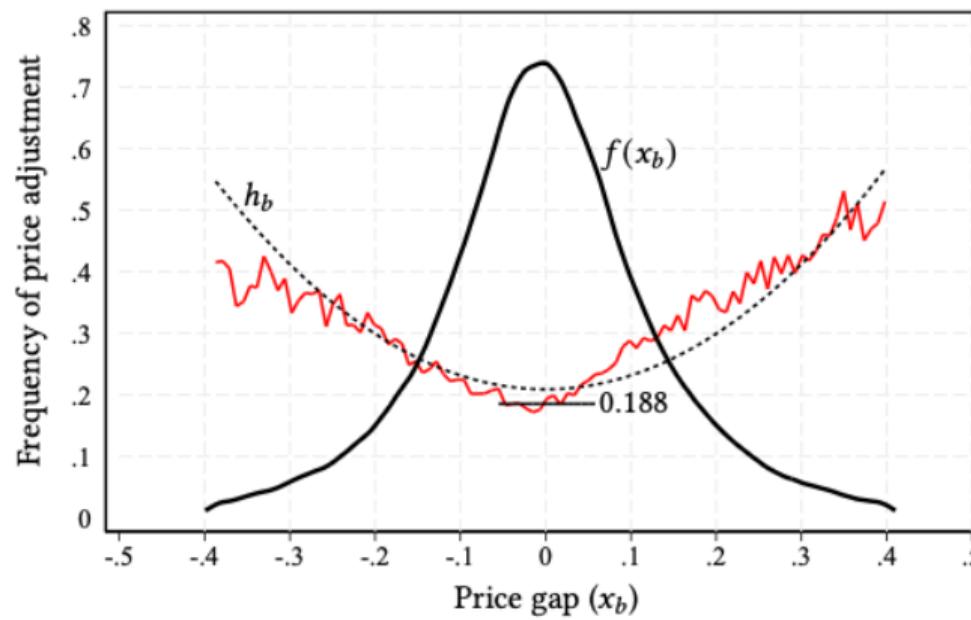
Using this measure, observe each firm's price gap before adjustment and whether / how much the firm changes its price. This enables:

- ▶ Estimating the empirical hazard: how the probability of a price change varies with the gap
- ▶ Examining price-change sizes relative to gaps
- ▶ Tracking how the distribution of price gaps shifts over time (e.g., during the 2021–22 cost shock)

Evidence, State-Dependent Adj Frequency (Extensive Margin)

In cross-section, firms with **larger absolute price gaps adjust more frequently**

Figure 6: Empirical GHF and distribution of price gaps



Evidence, Inflation Surge as a Shift in Price Gap Distribution

The 2021–22 inflation episode through the lens of price gaps:

- ▶ In 2022Q2, firms' real marginal costs jumped by +6.2% on average
- ▶ Result: the share of firms with big positive gaps surged, raising the average frequency of price adjustment from 25% to nearly 50% in that quarter
- ▶ Empirically, the distribution of gaps in 2022Q2 shifted rightward relative to pre-pandemic, and the mean adjustment probability roughly doubled
 - ▶ consistent with the model's prediction that large shocks trigger widespread repricing

The nonlinear micro pricing dynamics translated into a nonlinear aggregate inflation response.

A shock to costs of this magnitude led to a disproportionately large inflation jump, as many prices were updated.

Putting it Together: Model Validation and Fit

The authors embed the observed micro patterns into a **generalized state-dependent pricing model** and show it replicates macro dynamics:

- ▶ Calibrated menu-cost model (matching the micro moments) generates low, stable inflation in normal times and a nonlinear surge during 2021–22 when fed the cost shock sequence
- ▶ In contrast, a time-dependent (Calvo) model with the same average frequency fails to produce the surge — it would underestimate inflation given the large shock, because it lacks the mechanism for hazard to increase
- ▶ The state-dependent model's simulated inflation closely tracks actual inflation and price-change frequency over time

Allowing the probability of price change to rise endogenously during big shocks is crucial to explain 2021–22 inflation dynamics

Discussion

- ▶ Direct measures of firm-level price gaps using cost data
- ▶ Micro-founded explanation for the pandemic-era inflation surge, linking it to state-dependent repricing triggered by “cost shocks”
- ▶ Shows that standard time-dependent models (e.g. New Keynesian Phillips curve with Calvo pricing) are inadequate for large shocks
 - ▶ a generalized state-dependent framework can match both normal and surge inflation dynamics
 - ▶ important for policy strategy (e.g. see Fed framework review)

Supply Chain Constraints and Price Gaps

- ▶ Static optimal price absent nominal rigidities

$$p_t^o(f) = \mu + (1 - \Omega)mc_t(f) + \Omega p_t$$

- ▶ How should we think about pricing under capacity constraints?
- ▶ Argue this is an important feature of the data during covid
- ▶ Does this affect measurement of price gaps and link between large price gaps / evidence of state-dependent pricing frictions?

Simple Pricing Problem for Firms under Capacity Constraints

Firm ω sets $P_t(\omega)$ to solve:

$$\max_{\{P_t(\omega)\}} \mathbf{E}_0 \sum_{t=0}^{\infty} \frac{S_{0,t}}{P_t} [(P_t(\omega) - MC_t(\omega)) Y_t(\omega) - \Phi(P_{t-1}(\omega), P_t(\omega))]$$

$$\text{s.t. } Y_t(\omega) = \left(\frac{P_t(\omega)}{P_{Ht}} \right)^{-\varepsilon} Y_t$$

$$\text{and } Y_t(\omega) \leq \bar{Y}_t$$

$$\text{with } \Phi(P_{t-1}(\omega), P_t(\omega)) \equiv \frac{\phi}{2} \left(\frac{P_t(\omega)}{P_{t-1}(\omega)} - 1 \right)^2 P_{Ht} Y_t.$$

Pricing in Symmetric Equilibrium

Optimal Pricing:

$$0 = 1 - \varepsilon \left(1 - \frac{MC_t + \gamma_t}{P_{Ht}} \right) - \phi (\Pi_{Ht} - 1) \Pi_{Ht} + E_t \left[\frac{S_{t,t+1}}{\Pi_{t+1}} \phi (\Pi_{Ht+1} - 1) \Pi_{Ht+1}^2 \frac{Y_{t+1}}{Y_t} \right]$$

with $\Pi_{Ht} \equiv P_{Ht}/P_{H,t-1}$.

Complementary Slackness Condition:

$$\gamma_t [\bar{Y}_t - Y_t] = 0$$

plus $\gamma_t \geq 0$ and $Y_t \leq \bar{Y}_t$.

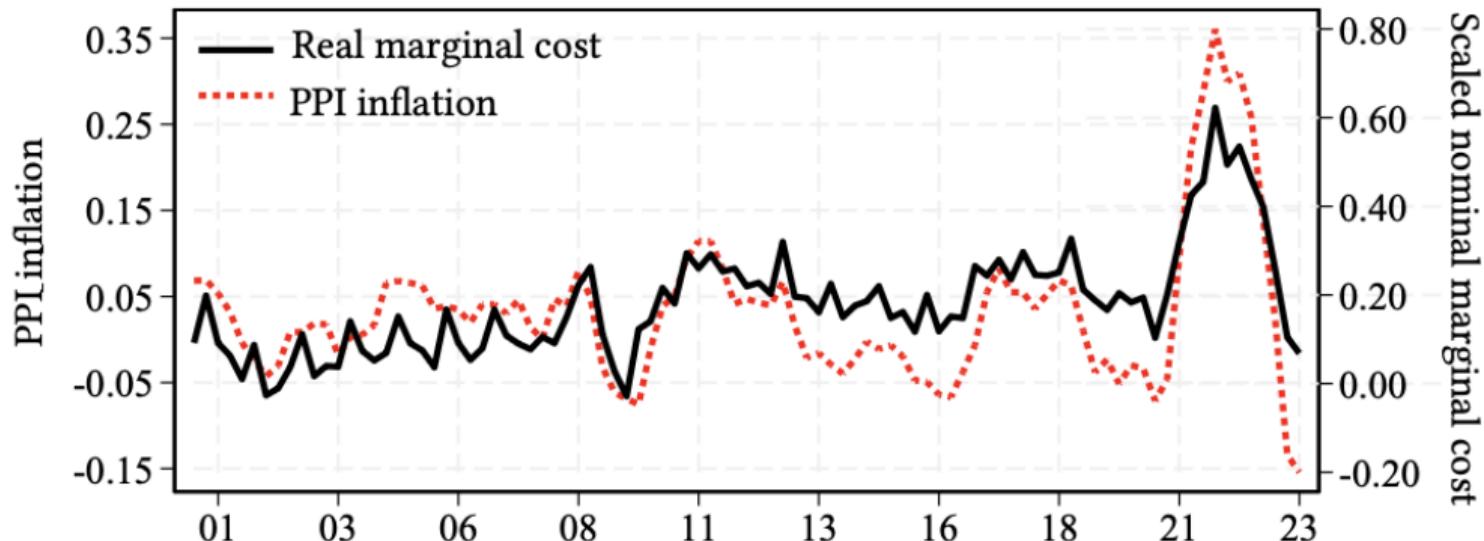
Slack constraint $\Rightarrow \gamma_t = 0 \Rightarrow$ usual price Phillips Curve holds.

Binding constraint $\Rightarrow Y_t = \bar{Y}_t \Rightarrow$ price determined by demand.

Estimated Marginal Costs

Figure 10: Inflation, cost, and markup dynamics

Panel a: Aggregate inflation and real marginal cost



What Kind of Shock Is the “Cost Shock”?

- ▶ Marginal cost constructed directly from firm-level accounting data
- ▶ Driven primarily by intermediate input prices, not labor
- ▶ No explicit notion of potential output or capacity utilization

Other Points..

- ▶ Generality: Analysis is based on Belgian manufacturing data – behavior in consumer-facing industries / services might differ
 - ▶ How broadly do these findings apply?
- ▶ Other markup questions: if markups or desired margins vary cyclically, the price gap estimation could be imperfect
- ▶ Menu cost model abstraction: Other frictions (e.g. information frictions, multi-product pricing) are abstracted away

Final Thoughts

- ▶ Awesome paper
- ▶ Fit of unusual Covid dynamics with the model