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STATE-DEPENDENT PRICING AND COST-PUSH INFLATION IN A PRODUCTION NETWORK ECONOMY

EUROPEAN CENTRAL BANK
EUROSYSTEM

State-dependent pricing and cost-push inflation in a production network economy

by Anastasiia Antonova

1 Introduction

Is observed inflation **demand-pull** or **cost-push**? Phillips curve

$$\pi_t = \kappa \cdot \tilde{y}_t + E\pi_{t+1} + \underbrace{u_t}_{\text{cost-push}}$$

Where residual u_t comes from? Sectoral shocks. (ex. Oil sector)

$$u_t = u(\text{shocks, prod. network, price rigidity})$$

State-dependent vs **non-state-dependent** price rigidity (ex. Menu-cost vs Calvo)

state-dependence = rigidity **depends on shock size**

NK + IO-network literature relies on non-state-dep. pricing (Erceg 2000, Aoki 2001, Rubbo 2022, La'O et al. 2022)

Yet, numerous empirical evidence of state-dep. pricing (Nakamura et al. 2008, Eichenbaum et al. 2011, Campbell et al. 2014, Carvalho et al. 2021 ...)

This project: role of state-dependent pricing in shaping cost-push effect in NK IO-network model

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2 Framework/Main results

NK production network model with distinctive feature: **information friction** resulting in **state-dependent price rigidity**

Main results (theoretical/empirical/quantitative)

- State-dep. may reverse the sign of cost-push effect
- 70% of US sectors have evidence of state-dep. pricing
- State-dep. affects size/sign of cost-push effect in US

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3 State-dependent price rigidity

Suitable "state" variable? Sectoral marginal cost vector is

$$\boldsymbol{mc_t} = m_t \cdot \mathbf{1} + \underbrace{-L\boldsymbol{a_t}}_{\text{productivities}} + \underbrace{(\tilde{L} - I)\boldsymbol{\mu_t}}_{\text{markups (endog.)}}$$

I define **relevant state in sector i** as $s_{t,i} = -\sum_j l_{ij} \cdot a_{t,j}$ where l_{ij} elements of Leontief inverse L, $a_{t,j}$ sectoral productivities

Intuition: i cares about productivity of its suppliers

Tractable state-dep. pricing: **sticky information** + **heterogeneous inattention**. Firms in sector i:

- track changes in $s_{t,i}$, that is $\Delta s_{t,i} = s_{t,i} - s_{t-1,i}$
- those with low inattention $x < |\Delta s_{t,i}|$ update their info.

Price flexibility $F_{t,i}$ = share updating info. $F_i(|\Delta s_{t,i}|)$

$$F_i(|\Delta s_{t,i}|) = \bar{F}_i + f_i \cdot \underbrace{log \frac{|\Delta s_{t,i}|}{E|\Delta s_{t,i}|}}_{\text{relevant state fluct.}}$$

- $\bar{F}_i$ is **average price flexibility** in sector i
- f_i **state dependence parameter**

4 State-dependence estimation

Model response of prices to shocks yields $\bar{F}_i$, f_i estimates

Intuition: strong average response = flexible prices; response depends on $|\Delta s_{t,i}|$ = state-dependence

Data/Methodology:
- prices, wages, consumption, hours worked for $\sim$360 sectors, 80% of cons. basket, monthly freq. for US; IO-network for model calibration
- compute sectoral shocks from the model
- estimate each $\bar{F}_i$, f_i model-based IV regression

5 Philips curve/decomposition

Consumer price inflation Phillips curve

$$\pi_t = \kappa_t \cdot \underbrace{\tilde{y}_t}_{\text{demand}} + (1-\kappa_t) \cdot \underbrace{\boldsymbol{\beta'} M_t F_t \cdot \boldsymbol{\hat{\pi}_t^\star}}_{\text{cost-push}} + (1-\kappa_t) \cdot \underbrace{\boldsymbol{\beta'} M_t F_t \cdot \boldsymbol{\tilde{e}_{t-1}}}_{\text{expectations}}$$

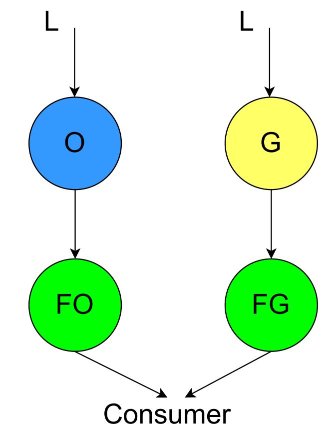
$\boldsymbol{\hat{\pi}_t^\star} = \boldsymbol{\hat{p}_t^\star} - \boldsymbol{\hat{p}_{t-1}}$ are price gaps (efficient minus true prices)
F_t is diagonal matrix of sectoral flexibility $F_{t,i}$

Cost-push inflation decomposition

$$u_t = \underbrace{\boldsymbol{\beta'} F_t \cdot \boldsymbol{\hat{\pi}_t^\star}}_{\text{main effect} = u_t^m} - \underbrace{\boldsymbol{\beta'}(I - M_t) F_t \cdot \boldsymbol{\hat{\pi}_t^\star}}_{\text{i-o effect} = u_t^v}$$

Interpretation: reset prices $p^{reset} = p^{efficient} + \Delta^{markups}$. Main effect obtains if $p^{reset} = p^{efficient}$

6 Example: commodity shock



Two commodities: Oil, Grain (fully flexible prices)

Two final goods: FO and FG (flexibility: F_t^{FO}, F_t^{FG})

Oil/grain shocks ϵ^{Oil}, ϵ^{Grain}

Oil shock: $u_t^m(Oil) = -\frac{1}{4} \cdot (F_t^{FO} - F_t^{FG}) \cdot \epsilon^{Oil}$

Grain shock: $u_t^m(Grain) = +\frac{1}{4} \cdot (F_t^{FO} - F_t^{FG}) \cdot \epsilon^{Grain}$

Non-state-dep.: let $F^{FO} > F^{FG}$:
under neg. **oil shock** $u_t^m > 0$; under neg. **grain shock** $u_t^m < 0$

State-dep.: oil shock: $F^{FO} > F^{FG}$; grain shock: $F^{FO} < F^{FG}$:
under negative **oil/grain shock** $u_t^m > 0$

State-dependence reverses cost-push effect!

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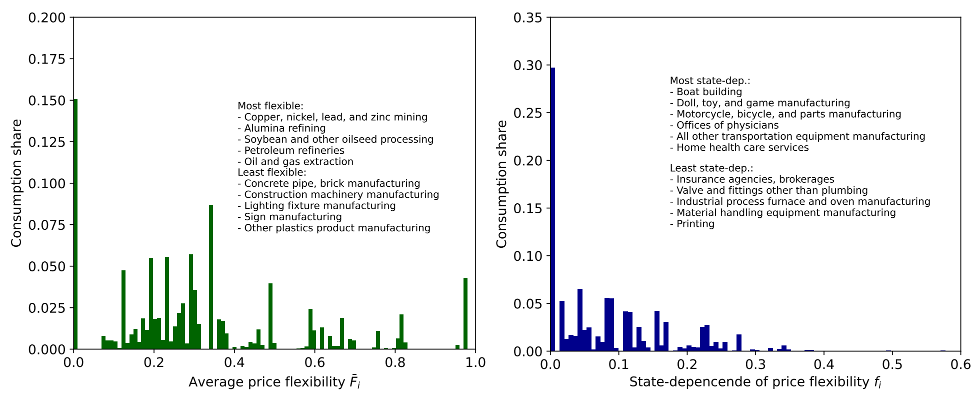
7 Flexibility/State-dependence estimates

Figure 1: Price flexibility/state-dependence estimates

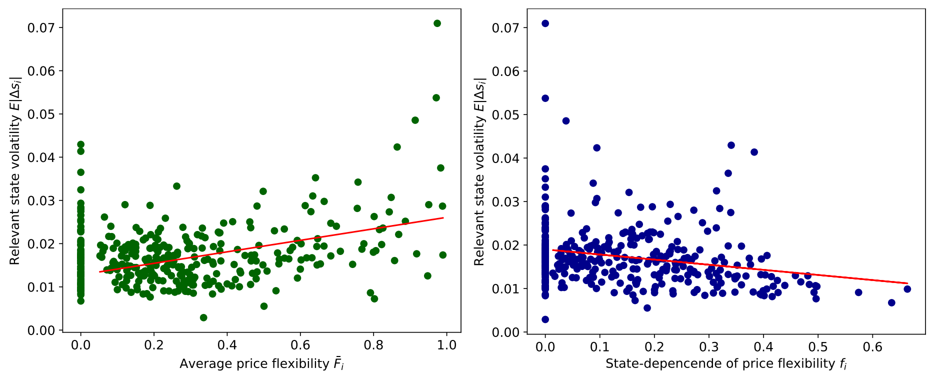
(a) Average price flexibility (b) State-dep. of price flexibility



Histogram of average price flexibility estimates $\bar{F}_i$ (a) and state-dependence parameter estimates f_i (b) across 364 sectors; sectors are weighted by consumption shares β_i; variation is plotted only for 90%-level significant estimates; **estimates insignificant at 90% level are forced to zero**; interpretation of state-dependence parameter f_i: 1.p.p. increase in $|\Delta s_{t,i}|$ above its time average leads to price flexibility increase of $0.01 \cdot f_i$.

Figure 2: Link with relevant state volatility

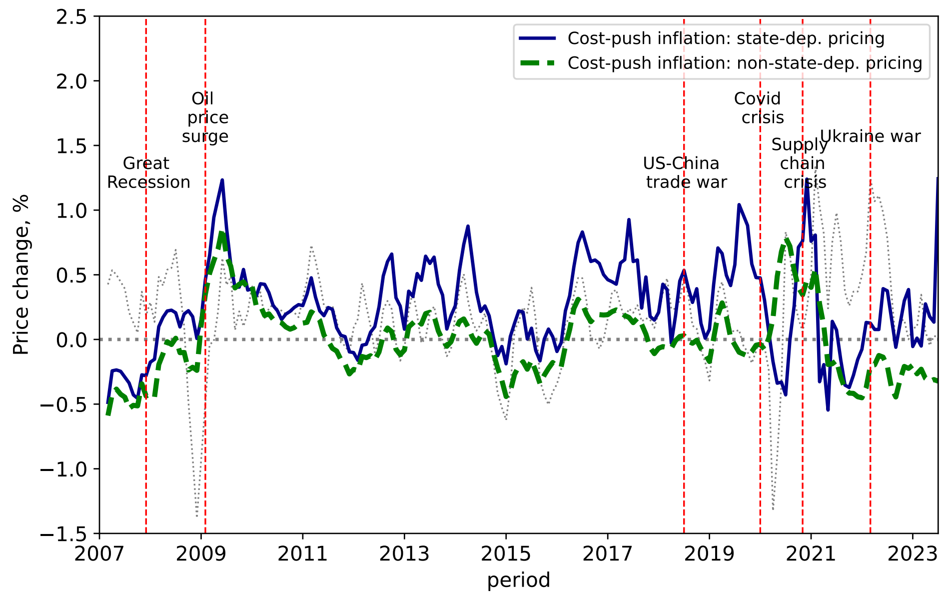
(a) Average price flexibility (b) State-dep. of price flexibility



Average price flexibility estimates $\bar{F}_i$ and state-dependence parameter estimates f_i are plotted against the time average volatility of sector-relevant productivity state $E|\Delta s_i|$; sectors are weighted by consumption shares β_i; estimates insignificant at 90% level are forced to zero; red lines correspond to linear regressions within the group of significant estimates; **correlation coefficient for panel (a) is 0.44 and correlation coefficient for panel (b) is -0.25**.

8 Cost-push effect in the US

Figure 3: Cost-push inflation and state-dependent pricing



Note: **Grey dotted line** plots observed CPI inflation.

9 Discussion

- State-dependence plays different roles in shaping cost-push inflation throughout recent history
  - amplification post-Great Recession
  - sign reversal/amplification post-Covid
- Recent high inflation in the US is only partially cost-push (demand/expectations factors might be more important)