Downward Price Rigidities and Inflationary Relative Demand Shocks

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Inflation, Inflation Expectations and Policy: New Perspectives

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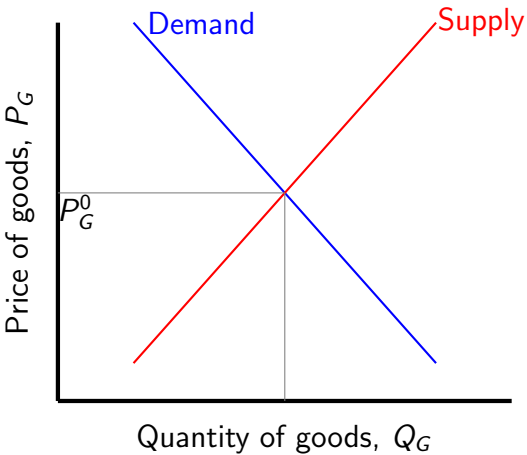
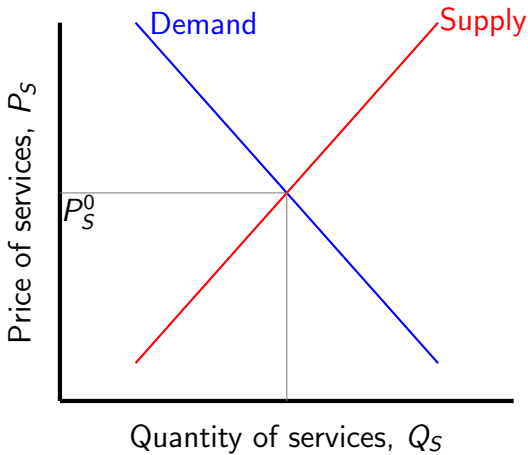
Can relative demand shocks be inflationary?

Two sectors: goods and services

$$P \approx \alpha P_G + (1 - \alpha) P_S$$

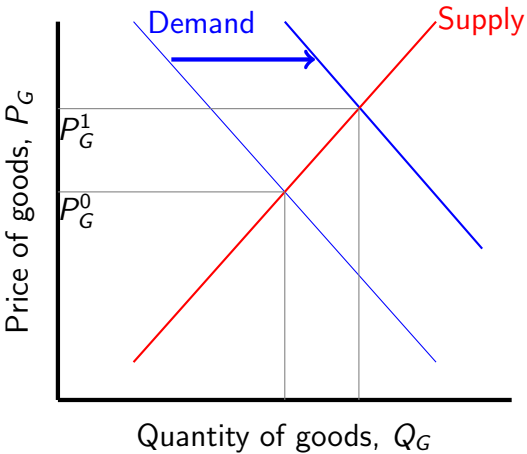


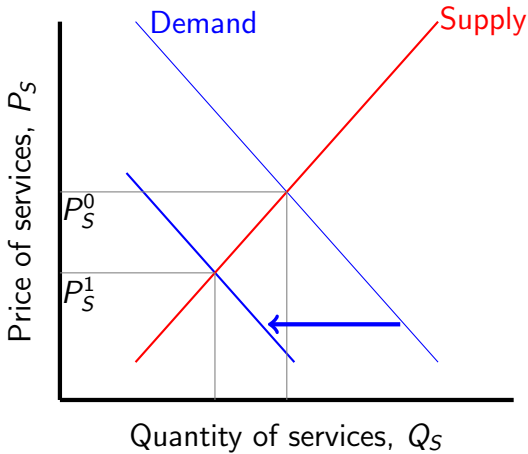


Can relative demand shocks be inflationary?

Effect of a relative demand shock on inflation:

$$\Delta \ln P \approx \alpha \ln \Delta P_G + (1-\alpha) \ln \Delta P_S = 0$$

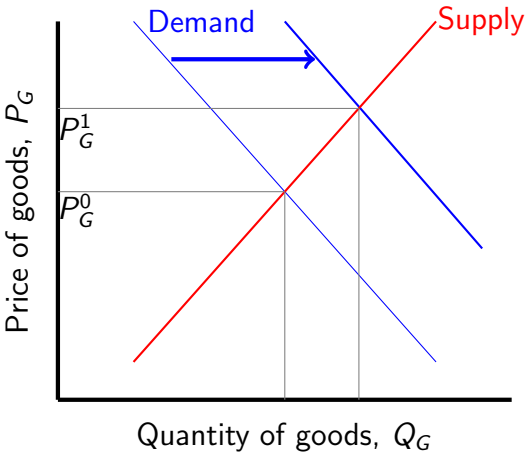


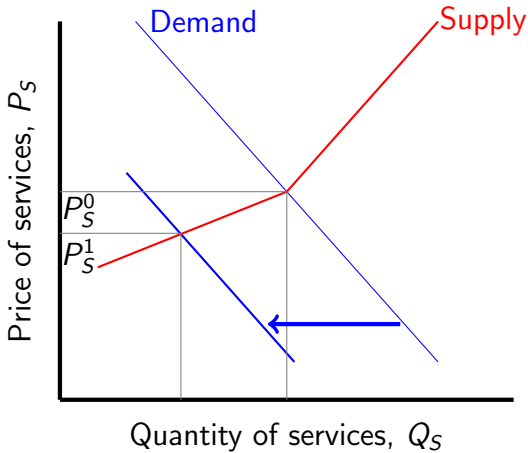


Can relative demand shocks be inflationary?

Effect of relative demand shock on inflation under **d**ownward **p**rice **r**igidity (DPR):

$$\Delta \ln P \approx \alpha \ln \Delta P_G + (1-\alpha) \ln \Delta P_S > 0$$





What we do in the paper and main results

- Present new empirical evidence on importance of DPR
  - Use data on individual CPI price quotes in the UK, 2017-2021
  - Lack of downward adjustment of services prices, even during the pandemic

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  - Lack of downward adjustment of services prices, even during the pandemic

- Illustrate mechanism in two-sector New Keynesian model with DPR
  - Relative demand shocks inflationary when prices are downwardly rigid
  - Inflationary relative demand shocks look like supply shocks in output-inflation space
  - Inflation can help 'grease the wheels of the product market' $\rightarrow$ calls for a more 'patient' monetary policy response
  - DPR amplify other price pressures resulting from relative demand shocks

Sources of downward price rigidity

Theory and anecdotal evidence

- Trend inflation induces firms to raise price by more following positive shock than to lower price following negative shock (Ball and Mankiw, 1994)
- Many producers are reluctant to reduce prices (Bewley, 2023)
  - kinked demand curve
  - heterogeneneity in the price elasticity of demand across customers
  - fixed contracts and quasi-fixed demand

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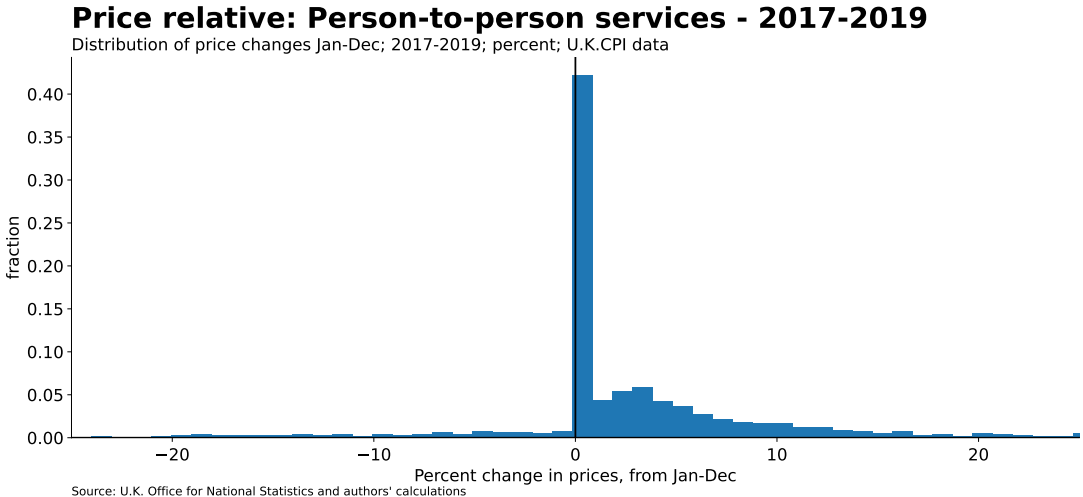
Evidence of DPR in the US and EA

- Price declines for services in the US much less common than for goods (Nakamura and Steinsson, 2008)
- Majority of service price changes in the EA are price increases (Gautier et al., 2024)

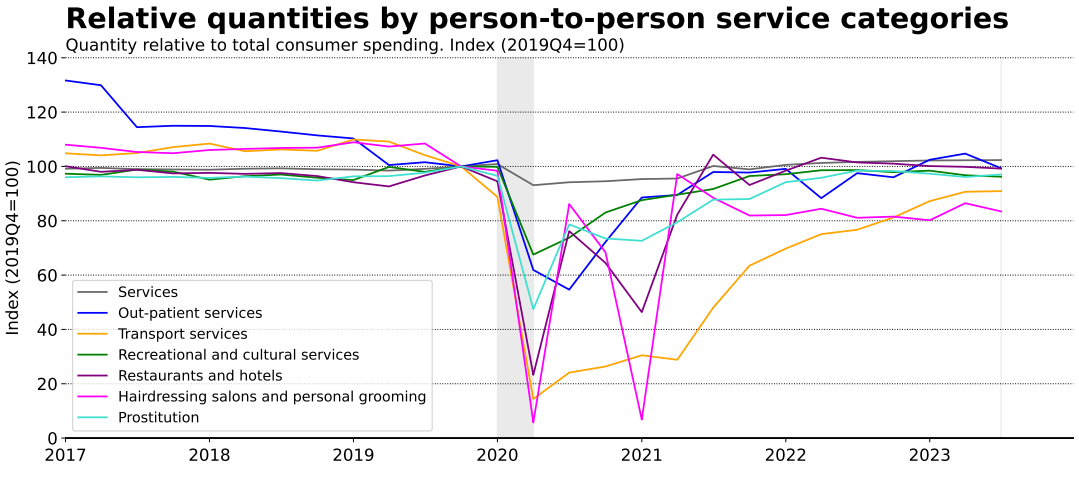
Empirical evidence

Some evidence of DPR in person-to-person services in the U.K.



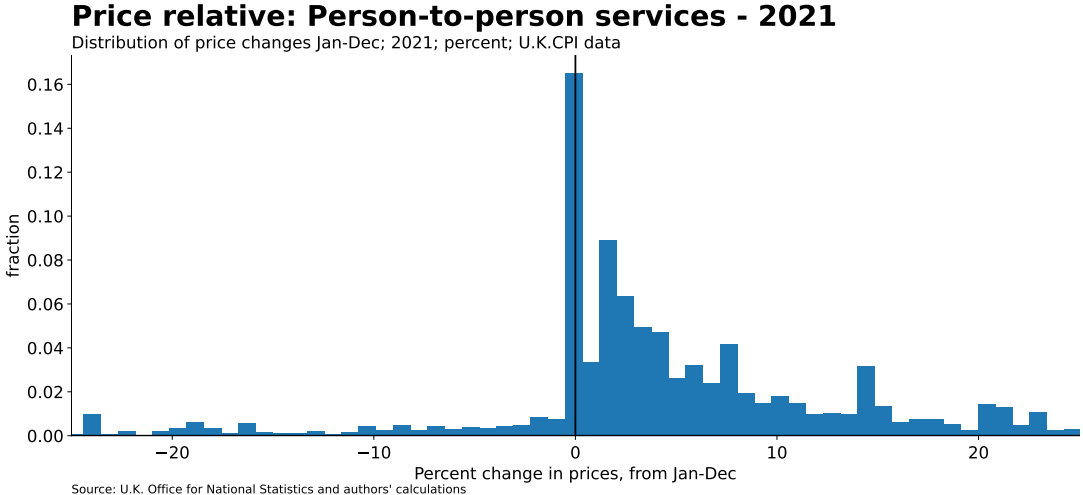
Note: Person-to-person services are 'Out-patient health services', 'Transport services', 'Recreational and cultural services', 'Restaurants and hotels', 'Hairdressing salons and personal grooming', and 'Prostitution'.

Unprecedented drop in demand for person-to-person services...



Source: U.K. Office for National Statistics and authors' calculations

...yet prices of these services rarely declined



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A two-sector New Keynesian model with downward price rigidity

Key elements of the model

- New Keynesian model with two sectors: goods and services (Cantelmo and Melina, 2023)
- Downward price ridigities in services sector (Kim and Ruge-Murcia, 2009)

Price adjustment cost function asymmetric for services

- Two sectors: goods and services, $j \in \{G, S\}$, with a continuum of varieties $\omega \in [0, 1]$

- The price adjustment cost function in sector j is given by:

$$\Gamma^j_{\omega,t} = \frac{\gamma_j}{\varsigma_j^2} \left\{ \exp\left[-\varsigma_j \left(\frac{P^j_{\omega,t} - P^j_{\omega,t-1}}{P^j_{\omega,t-1}} \right) \right] + \varsigma_j \left(\frac{P^j_{\omega,t} - P^j_{\omega,t-1}}{P^j_{\omega,t-1}} \right) - 1 \right\} \tag{1}$$

with $P^j_{\omega,t}$ price set by firm ω in sector j and $\gamma_j \geq 0$ degree of price stickiness

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  with $P^j_{\omega,t}$ price set by firm ω in sector j and $\gamma_j \geq 0$ degree of price stickiness

- ς_j determines the degree of asymmetry of the price adjustment cost
- Assume asymmetric price adjustment costs for services, i.e. $\varsigma_S > 0$, and symmetric price adjustment costs for goods, i.e. $\varsigma_G \to 0$

Consumption bundle consists of goods and services

- Consumption of household $i \in [0, 1]$:

$$C_{i,t} = \left[\alpha_t^{\frac{1}{\theta}} G_{i,t}^{\frac{\theta-1}{\theta}} + (1 - \alpha_t)^{\frac{1}{\theta}} S_{i,t}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

  with $G_{i,t}$ and $S_{i,t}$ consumption of goods and services, and $\theta \geq 1$ the elasticity of substitution between goods and services

- Relative demand shock:
  - Utility parameter α_t is time varying around a mean α
  - Relative demand shocks sole source of fluctuations
  - $\alpha_t > \alpha$ implies demand shifts away from services

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- We assume that CPI inflation and GDP are measured as fixed-weighted indices

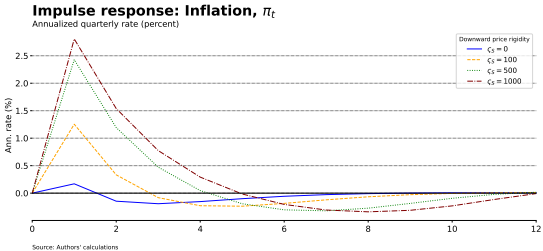
Results

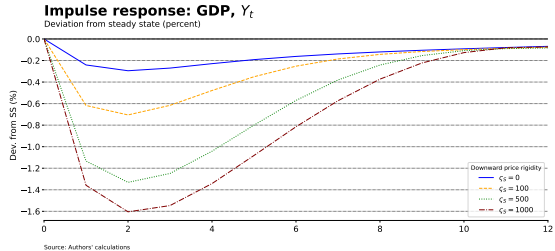
Main results from the model

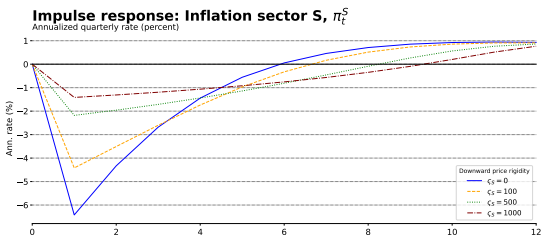
1. Inflationary impact of relative demand shocks depends on degree of DPR
2. Inflationary relative demand shocks look like supply shocks in output-inflation space
3. Inflation 'greases the wheels of the product market'
4. DPR amplify other price pressures resulting from relative demand shocks

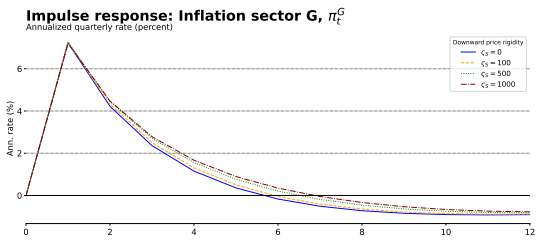
Inflationary impact of relative demand shocks depends on degree of DPR

Relative demand shocks are inflationary under DPR







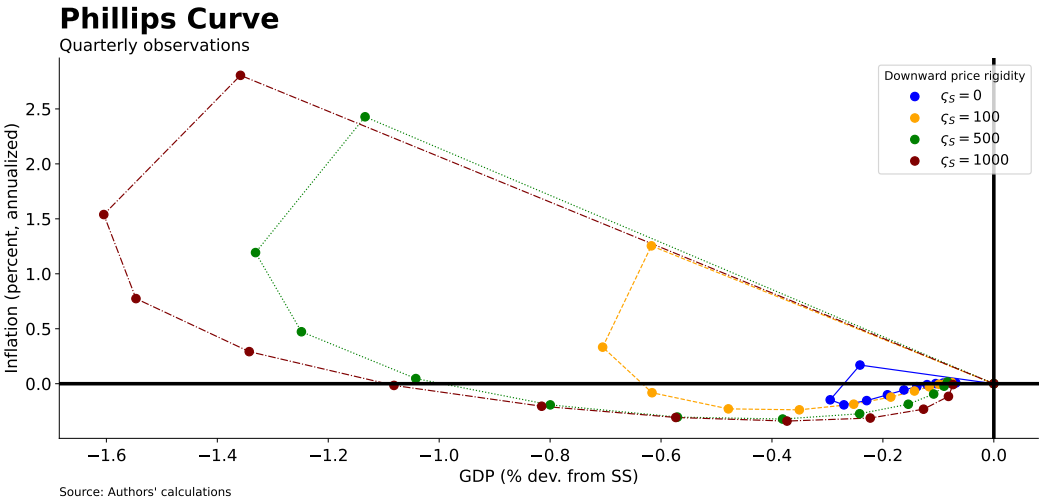


Note: Time period is a quarter. Shock is $(\alpha_t - 0.5) = 0.9\,(\alpha_{t-1} - 0.5)$, where $\alpha_1 = 0.58$.

Inflationary relative demand shocks

look like supply shocks in output-inflation space

Slope of empirical Phillips curve depends on degree of DPR



Source: Authors' calculations

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Inflation ‘greases the wheels of the product market’

Greasing the wheels in the product rather than labor market

- Inflation greases the wheels of the labor market
  - Downward nominal wage rigidities (DNWR) cause distortion in relative price of labor and hamper decline in real wages
  - Inflation accelerates this decline, reducing allocative distortions of DNWR
    (Tobin, 1972; Akerlof et al., 1996)

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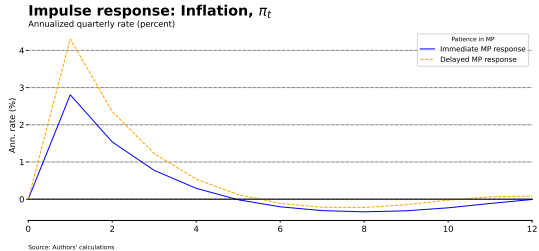
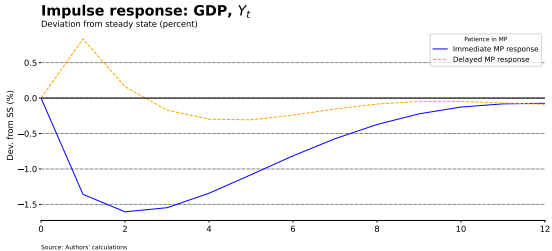
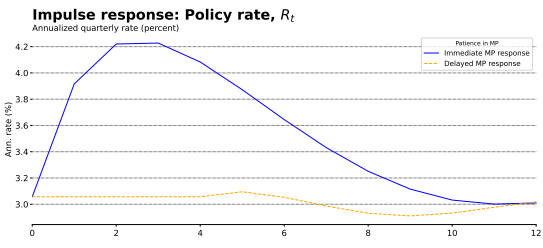
- Same intuition applies to product market
  - DPR slow down decline in relative price of services
  - Inflation helps accelerate this
  - Reduces allocative distortions resulting from shock
  - 'Patience' in monetary policy response to allow for adjustment of relative prices (Guerrieri et al., 2023)

'Patience' to allow for relative price adjustments







Note: Time period is a quarter. Service prices downwardly rigid with $\varsigma_S = 100$. Shock is $(\alpha_t - 0.5) = 0.9\,(\alpha_{t-1} - 0.5)$, where $\alpha_1 = 0.58$.

DPR amplify other price pressures
resulting from relative demand shocks

Introducing downward nominal wage rigidities

- DNWR can render Phillips curve non-linear and relative demand shocks inflationary (Guerrieri et al., 2021)

- Households face wage adjustment cost function similar to that faced by firms:

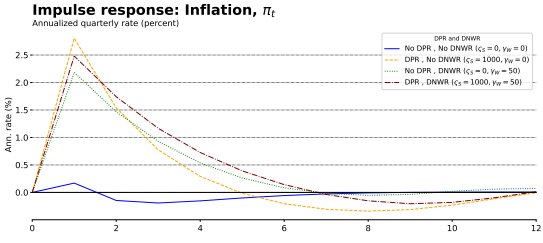
$$\Gamma_{i,t}^{w,j} = \frac{\gamma_j^w}{\left(\varsigma_j^w\right)^2} \left\{ \exp\left[-\varsigma_j^w \left(\frac{W_{i,t}^j}{W_{i,t-1}^j} - 1 \right) \right] + \varsigma_j^w \left(\frac{W_{i,t}^j}{W_{i,t-1}^j} - 1 \right) - 1 \right\} \tag{3}$$

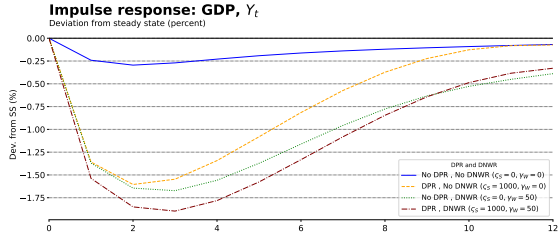
  with $W_{i,t}^j$ wage set by household i in sector j and $\gamma_j^w \geq 0$ degree of wage stickiness

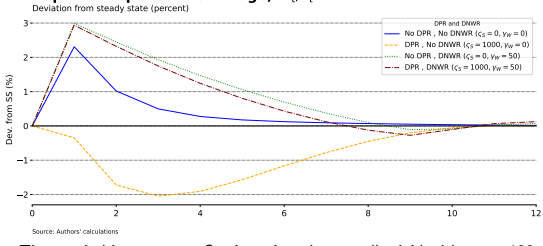
- ς_j^w determines the degree of asymmetry of the wage adjustment cost

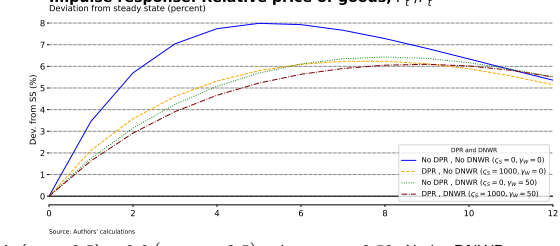
- Compare $\gamma_j^w = 0$ (flexible wages) against $\gamma_j^w = 50$ and $\varsigma_j^w = 1,000$ (DNWR)

DPR in conjunction with DNWR amplifies inflationary impact









Note: Time period is a quarter. Service prices downwardly rigid with $\varsigma_S = 100$. Shock is $(\alpha_t - 0.5) = 0.9\,(\alpha_{t-1} - 0.5)$, where $\alpha_1 = 0.58$. Under DNWR, we set $\varsigma^w = 1000$.

Introducing labor reallocation costs

- Costly reallocation of labor hampers expansion of supply in booming sectors
  (Ferrante et al., 2023)

- Labor supply is CES aggregate of hours worked in service, $N_{i,t}^S$, and goods, $N_{i,t}^G$, sector:

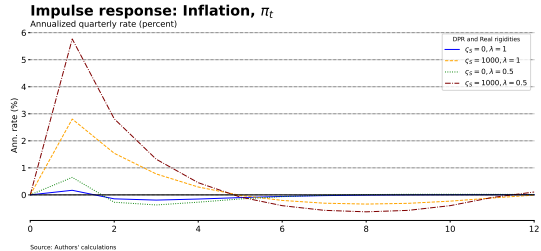
$$N_{i,t} = \left[\left(\chi^S\right)^{-\frac{1}{\lambda}} \left(N_{i,t}^S\right)^{\frac{1+\lambda}{\lambda}} + \left(1-\chi^S\right)^{-\frac{1}{\lambda}} \left(N_{i,t}^G\right)^{\frac{1+\lambda}{\lambda}} \right]^{\frac{\lambda}{\lambda+1}} \tag{4}$$

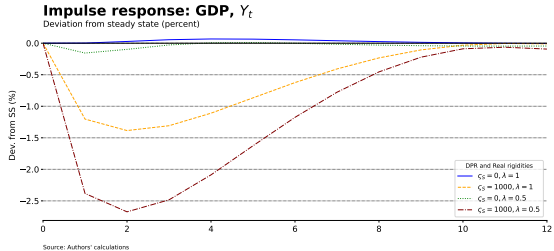
  with χ^S measuring the preference for labor supply in sector S

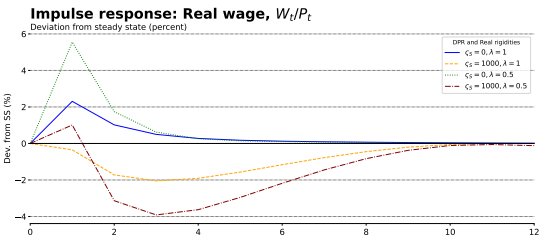
- $\lambda > 0$ controls the intratemporal elasticity of substitution of labor across sectors

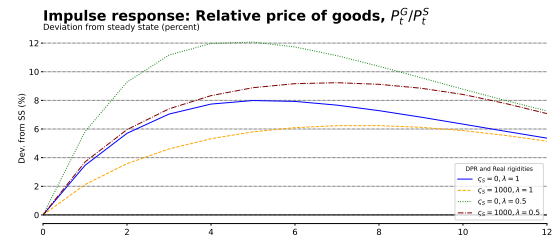
- Compare $\lambda = 1$ (baseline) against $\lambda = 0.5$ (greater real rigidities)

Relative demand shocks inflationary under real rigidites with DPR









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Introducing pent-up demand

- Pent-up demand can speed up adjustment and recovery from demand-driven recessions (Beraja and Wolf, 2021)
- Households derive utility from both current and past consumption on goods and services:

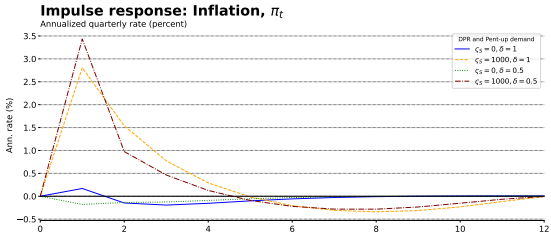
$$G_{i,t} = (1 - \delta_G)\, G_{i,t-1} + C^G_{i,t} \tag{5}$$

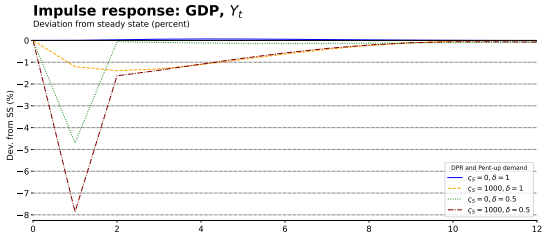
$$S_{i,t} = (1 - \delta_S)\, S_{i,t-1} + C^S_{i,t} \tag{6}$$

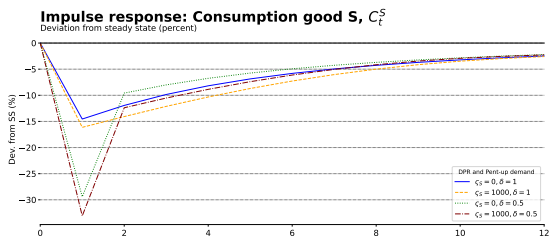
  with $\delta_j \in [0, 1]$ measuring the rate at which the importance of past consumption for current utility depreciates

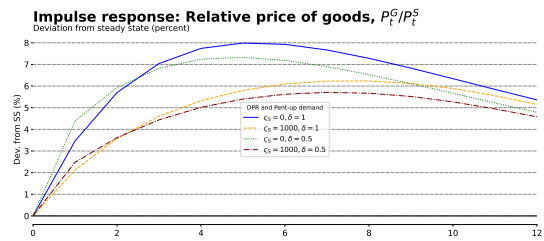
- Compare $\delta_j = 1$ (w/o pent-up demand) against $\delta_j = 0.5$ (w/ pent-up demand)

Pent-up demand accelerates inflationary cycle









Note: Time period is a quarter. Service prices downwardly rigid with $\varsigma_S = 100$. Shock is $(\alpha_t - 0.5) = 0.9\,(\alpha_{t-1} - 0.5)$, where $\alpha_1 = 0.58$.

Conclusion

Relative demand shocks can be inflationary in case of DPR

Upward pressures from demand shifts due to DPR

- Relative demand shocks affect nature of output-inflation trade-off faced by central bank when prices are downwardly rigid
- DPR induce distortion of allocation of real resources
- When relative demand shocks occur, inflation might alleviate the magnitude of these distortions (greases wheels)

Relative demand shocks not the only source of fluctuations

- Relative demand shocks important during COVID pandemic...
- ...but COVID pandemic exception—DPR likely less binding before 2020
- Important is real-time assessment of mixture of shocks at play

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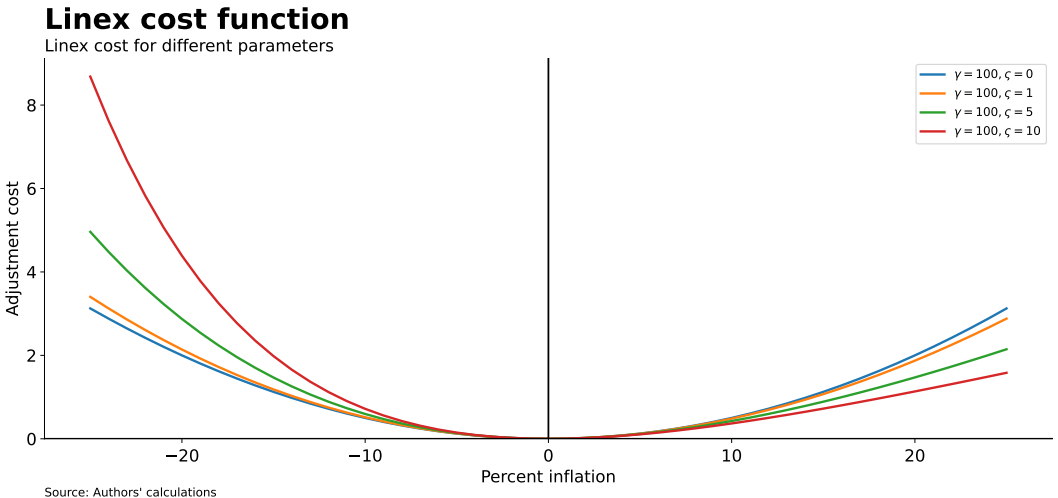
Background slides



Note: Linex cost function specification from Kim and Ruge-Murcia (2009). Price adjustment costs for services potentially asymmetric, $\varsigma_S \geq 0$, while $\varsigma_G = 0$.

Baseline calibration

Parameter	Description	Value
α	Steady-state share of good G in consumption basket	0.5
χ^S	Steady-state share of hours worked in sector S	1/2
β	Discount factor	0.9925
ϵ	Elasticity of substitution between varieties ω	6
λ	Elasticity of substitution of labor across sectors	1
σ	Inverse of intertemporal elasticity of substitution	1
φ	Inverse of Frisch elasticity of labor supply	1
γ_j	Degree of price stickiness in sector j	100
ρ_R	Interest rate smoothing parameter	0.8
ϕ_π	Monetary policy response to inflation	1.5
ρ_α	Persistence of relative demand shock	0.9
γ_j^w	Degree of wage stickiness in sector j	0
ς_j^w	Degree of wage adjustment cost asymmetry in sector j	1
η	Elasticity of substitution of labor varieties within sector j	21
θ	Elasticity of substitution between final goods	1
δ_j	Depreciation rate of good j	1