Shopping Time and Frictional Goods Markets:

Implications for the New-Keynesian Business Cycle Model

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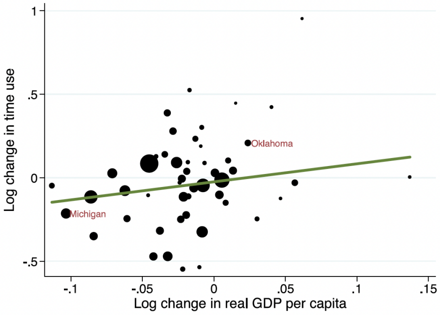
Understanding Society

Household Shopping Time Increases over the Business Cycle



NOTE: Taken from (Petrosky-Nadeau et al., 2016)

- **Shopping time** increases with income:
  - → **Evidence in favor of quantity/variety search!**
  - → Slope(Low-High Income): 1.53 – 4.01
  - → Drivers: consumer goods/services & travel time.
  - → Information costs are small and less cyclical!
- **Capacity utilization** increases with search effort.
  - → Search effort shows positive input to market result.
  - → Market efficiency depends on demand and supply.

⇒ **Business cycle models are silent about it!**

Barro (2025): The Old Keynesian Model

"A promising alternative to the non-price rationing of quantities in the Old Keynesian Model is a setup with search-and-matching frictions in the markets for goods and labor."

Implementing Procyclical Search Time in a NK Model

Research Question

How does costly shopping effort and imperfect goods market matching influence time allocation of households over the business cycle and thus the supply and demand channels of the New-Keynesian (NK) model?

Research Approach/Methods

- Small-sized DSGE model with **variable search effort and imperfect goods matching**.
- **Pen-and-paper:** Linearization and channel decomposition by hand!
- **Simulation** of calibrated (and extended) model using Dynare.

Literature & Contributions: Separating Search from Home Production

- **Home Production Literature:** Becker (1965), Benhabib et al. (1991), Greenwood & Hercowitz (1991), Lester (2014), Gnocchi et al. (2016).

  $\rightarrow$ *Contribution:* Separate search effort (market impact) from home production.

- **Search-and-Matching Literature:** Diamond (1971, 1982), Benabou (1988, 1992), Burdett & Judd (1993), Kaplan & Menzio (2016), Michaillat & Saez (2015, 2024), Petrosky-Nadeau & Wasmer (2015), Petrosky-Nadeau et al. (2016, 2021), Qiu & Rios-Rull (2022), Bai et al. (2025), Den Haan & Sun (2024).

  $\rightarrow$ *Contribution:* Model flex-search-sticky-price nexus and derive reduced-form GE model.

- **NK-DSGE Literature:** Erceg et al. (2000), Christiano et al. (2005), Smets and Wouters (2007), Gali (2011), Ascari et al. (2020).

  $\rightarrow$ *Contribution:* Analyze impact of search costs & market tightness on Euler & Phillips curves.

- **Customer Capital & Spatial Search:** Drozd and Nosal (2012), Gilchrist et al. (2017), Gourio and Rudanko (2014), Paciello et al. (2019), Schmitt-Grohe and Uribe (2025).

  $\rightarrow$ *Contribution:* Complementary approach with focus on market interactions.

Main Findings: A NK Model that looks more like a RBC Model

- **State-Dependent Price Elasticity of Demand** driven by Goods Market Tightness:
  - → Second cost of consumption varying in market tightness and affecting demand function.
  - → Euler equation slope ten times smaller (closer to the data)!
- **Endogenous Capacity Utilization** driven by Search Effort:
  - → Search effort as latent input factor increases firm productivity (trade-off with markups).
  - → Phillips curve is about 12% steeper.
- The NK Model calibrated to slopes in the data **resembles more an RBC model.**
  - → Output gap variation decreases significantly.
  - → Monetary Policy has significantly lower allocative power.
  - → Cost-push shocks arise naturally in this framework as price elasticity is endogenous.

Outline of the Presentation

1. **Introduction**
2. **Model Setup:** Optimization Problems and Calibration
3. **Linearized Dynamics:** Market Efficiency, Price Elasticity, and real GDP
4. **Simulations:** Decomposing IRFs to Technology, Monetary Policy, and Cost-Push Shocks
5. **Robustness Analysis:** (More) Labor Frictions, Capital (Utilization), and Long-Term Search Channels
6. **Concluding Remarks**

Model Framework

Goods Market Matching: Search Effort as a Utilization Driver

Matching function as a modeling short cut of heterogeneity:

$$\text{Output:} \quad C_{M,t}(i) = \psi_t \left[\gamma_S H_{S,t}(i)^{\Gamma_S} + (1-\gamma_S)\, S_t(i)^{\Gamma_S}\right]^{\frac{1}{\Gamma_S}} \tag{1}$$

$$= \boldsymbol{\psi_t \left[\gamma_S x_t(i)^{\Gamma_S} + (1-\gamma_S)\right]^{\frac{1}{\Gamma_S}}} S_t(i)$$

$$\text{Utilization:} \quad \Leftrightarrow \frac{C_{M,t}(i)}{S_t(i)} = \boldsymbol{q_t} \tag{2}$$

Properties of the Goods Market

- *Broad search cost:* shopping time, travel time (location, availability), information (limited) . . .
- There is always some idle production capacity if $\psi < 1$ and $\gamma_S > 0$.
- The impact of search effort on market matching increases in $\boldsymbol{\gamma_S}$.
- Amount of matched goods **increases in goods market tightness, $x_t(i)$!**

HH Utility: Search Costs depend on Market Tightness

Intertemporal utility maximization:

$$\mathbb{U}_t = \max_{C_t(i),H_{S,t}(i),H_{H,t},H_{M,t},B_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}-1}{1-\sigma} - \mu_{S,t} \frac{H_{S,t}^{1+\nu_S}}{1+\nu_S} - \mu_H \frac{H_{H,t}^{1+\nu_H}}{1+\nu_H} - \mu_M \frac{H_{M,t}^{1+\nu_M}}{1+\nu_M} \right) \quad (3)$$

$$\text{Budget Constraint:} \quad B_t = (1+r_{t-1}) B_{t-1} + W_t H_{M,t} - \int_0^1 P_t(i) C_{M,t}(i) di + \Pi_t \quad (4)$$

$$\text{Market Goods:} \quad C_{M,t} = \left(\int_0^1 C_{M,t}(i)^{\frac{\epsilon_t - 1}{\epsilon_t}} di \right)^{\frac{\epsilon_t}{\epsilon_t - 1}} \quad (5)$$

$$\text{Composite Goods:} \quad C_t = \left[\gamma_H C_{H,t}^{\Gamma_H} + (1-\gamma_H) C_{M,t}^{\Gamma_H} \right]^{\frac{1}{\Gamma_H}} \quad (6)$$

$$\text{Trade Law of Motion:} \quad C_{M,t}(i) = f_t(i) \cdot H_{S,t}(i) \quad (7)$$

Cyclical Search Cost of Consumption

$\Rightarrow$ Cost of consumption: (1) Purchase price, and (2) search cost dependent on market tightness.

Demand Function: Price Elasticity of Demand decreases in Search Prices

Demand function (derived from household utility maximization):

$$\frac{P_t(i)}{P_t} = \underbrace{\frac{\frac{\partial \mathbb{U}_t}{\partial C_t(i)}}{muc_t}}_{\substack{\text{Marg. Utility}\\ \text{of Consumption}}} - \underbrace{\frac{\frac{\partial \mathbb{U}_t}{\partial H_{S,t}(i)}}{muc_t} \times f\left(x_t(i)\right)^{-1}}_{\text{Search Price } = P_{S,t}(i)} \tag{8}$$

Price elasticity of demand (FOC of demand function wrt $P_t(i)$):

$$\Xi_t(i) = (-\epsilon_t)\left[1 + \frac{P_t}{P_t(i)} P_{S,t}(i)\right]^{-1} \tag{9}$$

Cyclicality of the Price Elasticity of Demand

$\Rightarrow$ Price elasticity decreases in search prices as posted price share of total consumption costs drops!

Firm Profits: Markups vs Capacity Utilization

Intertemporal profit maximization:

$$\Pi_t = \max_{P_t(i), C_{M,t}(i), H_{M,t}(i), \boldsymbol{S_t(i)}, \boldsymbol{x_t(i)}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{0,t} \left[P_t(i) C_{M,t}(i) - W_t H_{M,t}(i) \right] \tag{10}$$

$$\text{Resource Constraint}: \quad \left(1 + \frac{\kappa_P}{2}\left(\frac{P_t(i)}{P_{t-1}(i)} - 1\right)^2\right) \boldsymbol{S_t(i)} = A_t H_{M,t}(i) \tag{11}$$

$$\text{Demand Function:} \quad \frac{P_t(i)}{P_t} = \frac{\frac{\partial \mathbb{U}_t}{\partial C_t(i)}}{muc_t} - \frac{\frac{\partial \mathbb{U}_t}{\partial H_{S,t}(i)}}{\boldsymbol{muc_t}} \times \boldsymbol{f\left(x_t(i)\right)^{-1}} \tag{12}$$

$$\text{Trade Law of Motion}: \quad C_{M,t}(i) = \psi_t \left[\gamma_S x_t(i)^{\Gamma_S} + (1 - \gamma_S)\right]^{\frac{1}{\Gamma_S}} S_t(i) \tag{13}$$

Trade-Off: Markup vs Utilization

Higher posted prices raise markups but lower HH search effort (capacity utilization)!

General Equilibrium: Sticky Wages and a Taylor Rule

- **Representative firm and household:** Symmetric firm technology and preferences!
- **Numeraire good:** Real GDP/market consumption.
- **Sticky wages** similar to Erceg et al. (2000).
- **Monetary policy rule** (Taylor (1993)):

$$\frac{1+r_t}{1+r} = \left(\frac{1+r_{t-1}}{1+r}\right)^{i_r} \left[\left(\frac{\pi_t}{\pi}\right)^{i_\pi} \tilde{Y}_t^{i_{Gap}}\right]^{1-i_r} M_t \tag{14}$$

- **Shock processes:**

$$X_t = X^{1-\rho_X} X_{t-1}^{\rho_X} \varepsilon_{X,t}, \quad \varepsilon_{X,t} \sim \mathcal{N}(0, \sigma_X^2) \tag{15}$$

- **Shocks:** TFP, Monetary Policy, Elasticity of Substitution, Search Effort, Goods Market Mismatch.

Calibration of the Model

Parameter	Value	Parameter	Value	Parameter	Value
β	0.99	μ_H	$\frac{\bar{H}_H}{\bar{H}_M} = 0.54$	ϵ_W	$\bar{u} = 0.043$
σ	1.5	γ_H	0.55	κ_W	$\lambda_u = -0.026$
μ_M	$\bar{H}_M = 1$	Γ_H	0.5	i_R	0.8
ν_M	2	ν_H	ν_M	i_π	1.7
ϵ	$\frac{1}{mc} = 1.2$	κ_P	$\lambda_{ls} = 0.047$	i_{Gap}	0.12
ψ	$q = 0.86$	μ_S	$x = 1$	γ_S	$[0.11 \quad 0.32]$
ν_S	$[0 \quad 5]$	Γ_S	$[-2.7 \quad 0]$		

We **target moments from the empirical literature** as follows:

- Price (labor share) and wage (unemployment) Phillips curve slopes as in the data.
- Time allocation (market, home, search) according to American Time Use Survey.
- Goods market SaM parameters following Bai et al. (2025), Qiu and Rios-Rull (2022).
- $\frac{\nu_S}{\nu_M} = \frac{\nu_H}{\nu_M} = 1$: Time allocation elasticities symmetric across uses.

Dynamics Linearized Model

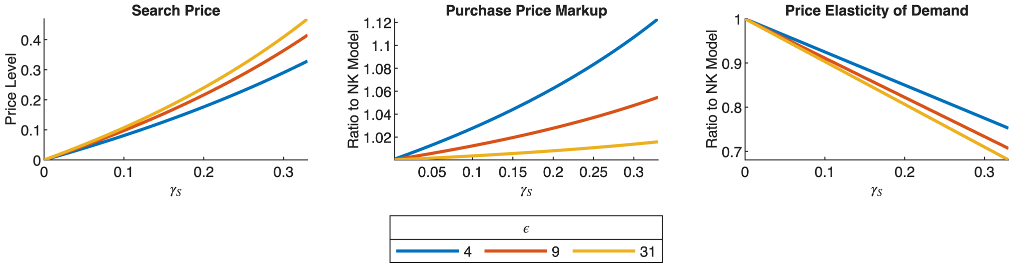
A Nested Five-Equation NK Model

Steady-State: GDP decreases in Price Elasticity and Markups

Full Steady-State

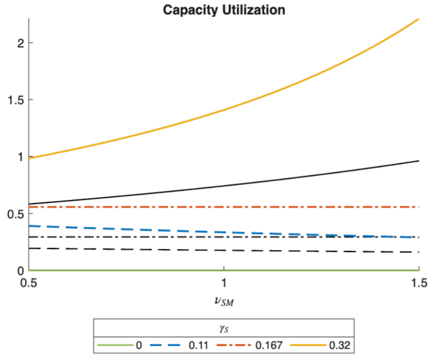
Real GDP decreases in idle capacity and increases in price elasticity:

$$Y = \underbrace{q}_{\substack{\text{Idle}\\\text{Capacity}}} \cdot \underbrace{\left[\overbrace{\frac{\xi_{C_M}(1-\phi_\epsilon)}{\mu_M C^\sigma}}^{\text{Marginal Utility}} \cdot \frac{\epsilon_W - 1}{\epsilon_W} \cdot q \cdot \overbrace{\frac{\epsilon - 1}{\epsilon}\left(1 + \frac{\phi_\gamma}{\epsilon}\right)^{-1}}^{\text{Marginal Costs}} \right]^{\frac{1}{\nu_M}}}_{\text{Total market hours}} \tag{16}$$



Procyclical Utilization is driven by Price Elasticity

$$\boxed{\tilde{q}_t = \frac{\psi\phi_\gamma}{1+\nu_S-\Gamma_S\left(1+\phi_\gamma\right)}\left[\left(1-\phi_\epsilon\right)\epsilon\tilde{mc}_t-\left(\nu_S+\phi_C\right)\tilde{Y}_t\right]} \quad (17)$$



Assume Okun's Law: $\tilde{Y}_t = -2.23\tilde{u}_t$

- Capacity utilization gap variation ...
  - $\rightarrow$ ... increases in γ_S (search productivity)
  - $\rightarrow$ ... increases in Γ_S (input substitutability)
- $\frac{\nu_S}{\nu_M}$ amplifies marginal costs variation:
  - $\rightarrow$ $\gamma_S < 0.167$: *Labor demand channel* dominates:

    Hours worked increase in marginal cost.

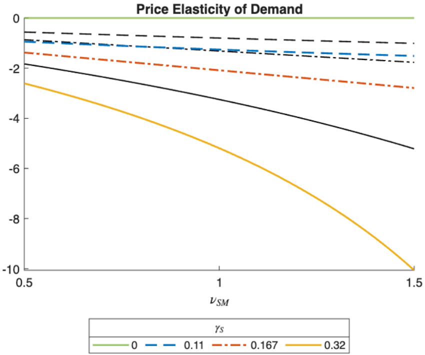
    Rel. higher search cost convexity ($\frac{\nu_S}{\nu_M}\uparrow$) lowers slope.
  - $\rightarrow$ $\gamma_S > 0.167$: *Price elasticity channel* dominates:

    Hours worked decrease in marginal cost.

    Rel. higher search cost convexity ($\frac{\nu_S}{\nu_M}\uparrow$) rises slope.

Price Elasticity depends on Variation in Market Tightness

$$\boxed{\tilde{\Xi}_t = -\phi_\epsilon \left[\epsilon \tilde{mc}_t + \frac{\Gamma_S}{1-\phi_\epsilon} \frac{1+\phi_\gamma}{\psi \phi_\gamma} \tilde{q}_t \right]} \tag{18}$$

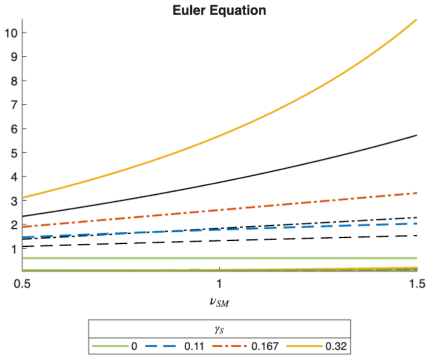


Assume Okun's Law: $\tilde{Y}_t = -2.23 \tilde{u}_t$

- Price elasticity variation ...
  - $\rightarrow$ ... decreases in search prices.
  - $\rightarrow$ ... is thus the mirror image of utilization.
- Slope depends on super-elasticity: $\phi_\epsilon = \frac{\epsilon - 1}{\epsilon} \gamma_S$.
- For $\Gamma_S = -\infty$, its slope reduces to approx. -1.26.

Euler Equation: Monetary Policy looses its Power

$$\boxed{\tilde{r}_t - \mathbb{E}_t \hat{\pi}_{t+1} = \phi_C \mathbb{E}_t \Delta \tilde{Y}_{t+1} - \mathbb{E}_t \boldsymbol{\Delta} \tilde{\boldsymbol{\Xi}}_{t+1}} \tag{19}$$



Assume Okun's Law: $\tilde{Y}_t = -2.23\tilde{u}_t$

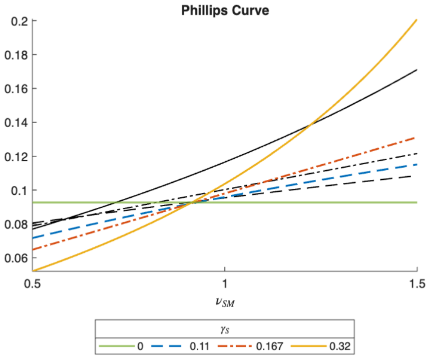
- Search price growth is inflationary!
  - → Consumption growth increases in price elasticity.
  - → However, price elasticity is countercyclical!
  - → Hence, consumption grows less for interest rate cut.
- Data: Slope positive, close to zero (Ascari et al., 2021).

⇒ Monetary policy has a **lower impact on consumption growth** compared to the NK model!

- → Impact of interest rate about **ten times smaller!**

Phillips Curve: Trade-Off Markups and Utilization

$$\hat{\pi}_t = \frac{1+\phi_\gamma}{\kappa_P}\left[\epsilon(1-\phi_\epsilon)\tilde{mc}_t + \frac{\Gamma_S}{\psi}\tilde{q}_t\right]\beta\mathbb{E}_t\hat{\pi}_{t+1} \tag{20}$$



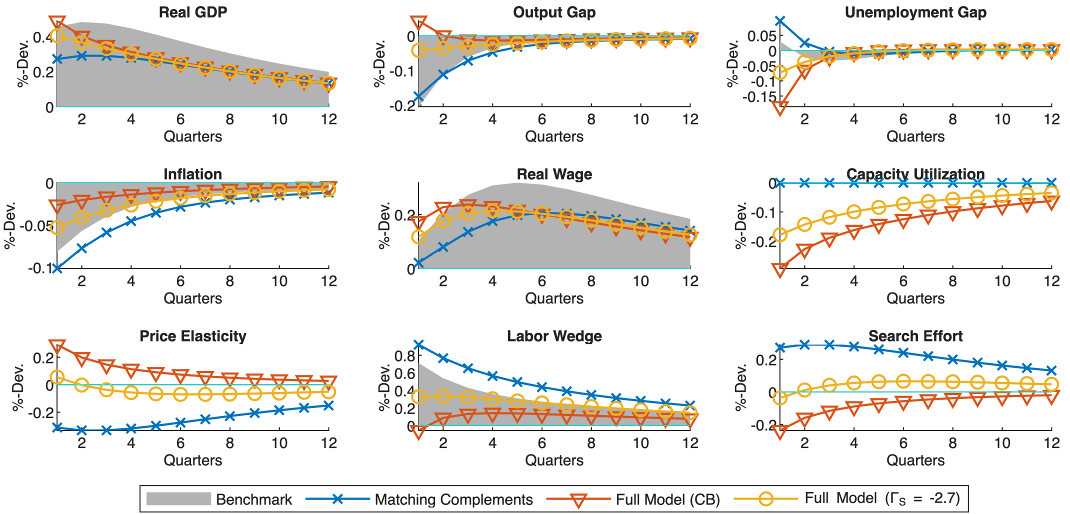
Assume Okun's Law: $\tilde{Y}_t = -2.23\tilde{u}_t$

- Labor share slope fixed to empirical counterpart!
- Identical slopes for $\bar{\nu}_{SM}(\Gamma_S = 0) \approx 0.9$.
  - $\rightarrow$ Matching input share constant as convexity equal.
- $\frac{\nu_S}{\nu_M} > \bar{\nu}_{SM}$: **Price setting becomes more flexible** as adjustment through utilization is more costly.
  - $\rightarrow$ Firms adjust prices through less convex margin.
  - $\rightarrow$ Marg. costs increase in $\frac{\nu_S}{\nu_M}$ as for cap. utilization.
- For $\Gamma_S < 0$: Lower substitutability of matching inputs leads to lower adjustment through utilization.

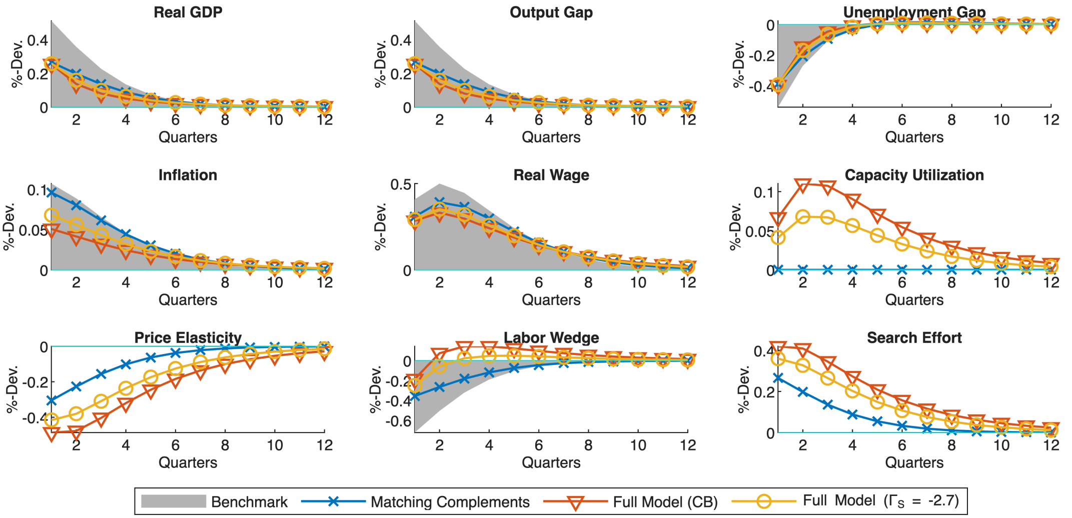
Model Simulations

IRFs to TFP, Policy, and Cost-Push Shocks

Impulse Responses to an Expansionary TFP Shock

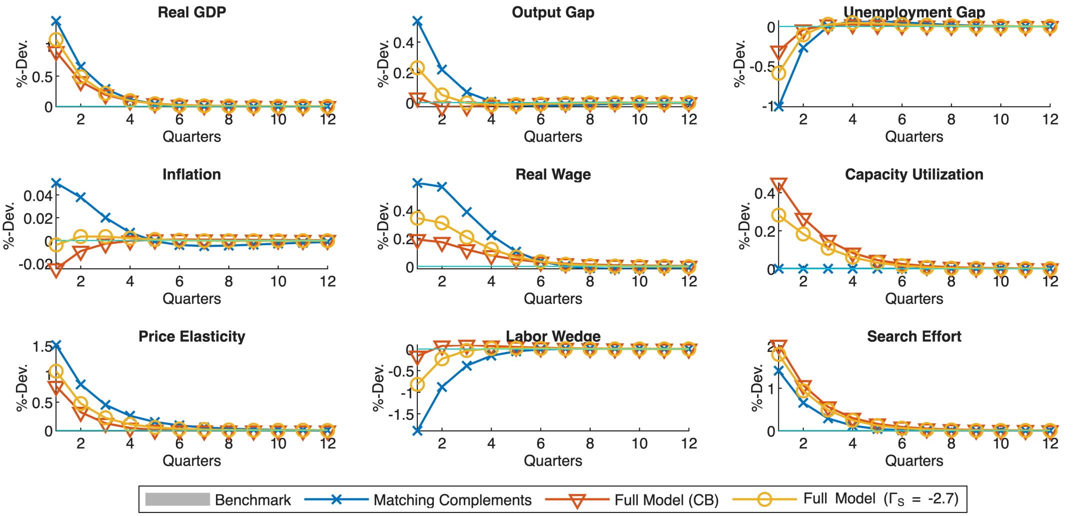


Impulse Responses to an Expansionary Monetary Policy Shock



Impulse Responses to an Expansionary Search Effort Shock

Cost-Push Comparison



Second Moments: Can the Model Match Search Data?

Table 1: Relative Standard Deviations and Correlations of Model Simulations

NK-SaM Model	Technology		Demand (Policy)		Cost-Push (EIS)		Search Effort	
Variable	Rel.Std.	Corr.	Rel.Std.	Corr.	Rel.Std.	Corr.	Rel.Std.	Corr.
Output Gap	0.08	0.28	1.00	1.00	0.45	0.94	0.06	0.30
UE Gap	0.29	-0.70	1.48	-0.96	1.43	-0.98	0.33	-0.92
Inflation	0.05	-0.99	0.24	0.94	0.04	-1.00	0.03	-0.99
Real Wage	0.58	0.91	1.82	0.80	1.06	0.82	0.27	0.90
Utilization	**0.57**	-1.00	**0.61**	0.67	**0.70**	-1.00	**0.53**	0.99
Marginal Cost	0.22	-0.95	1.14	0.87	1.77	0.95	0.36	-1.00
Price Elasticity	**0.52**	0.95	**2.67**	-0.87	**13.56**	0.97	**0.86**	1.00
Labor Wedge	0.37	0.42	1.13	-0.35	2.97	-1.00	0.23	-0.51
Search Effort	**0.42**	-0.95	**2.29**	0.87	**0.72**	-1.00	**2.30**	1.00

NOTE: The table shows simulated second moments for the benchmark and NK-SaM model. It shows relative standard deviations - standard deviation of each variable relative to standard deviation of real GDP - and correlations of each variable with real GDP. We consider each shock separately in the simulation.

Robustness Analysis

The Results are Robust to a Variety of Extensions

1. GHH Preferences: Reduce slopes by approx. 25%.
2. No Home Production: Increases slopes by 33%.
3. No Sticky Wages: Increases slopes by 25% to 50%.
4. Capital (Utilization): Labor wedge becomes acyclical.
5. Long-Term Contracts and Inventories:
   - Inventories quantitatively and qualitatively irrelevant.
   - Long-term contracts reduce search costs significantly.

Conclusion

Concluding Remarks

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Thank you for your attention!

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Paper:

Appendix

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Appendix - Labor Union Maximization Setup

Back

Optimization Problem:

$$\Pi_{U,t} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{0,t} \left[W_t \left(\int_0^1 H_{M,t}(i) di - \left(\int_0^1 H_{M,t}(j)^{\frac{\epsilon_W - 1}{\epsilon_W}} dj \right)^{\frac{\epsilon_W}{\epsilon_W - 1}} \right) \right] \tag{21}$$

First-Order Condition:

$$W_t(j) \left(\frac{H_{M,t}(j)}{H_{M,t}} \right)^{\frac{1}{\epsilon_W}} = W_t \tag{22}$$

Appendix - Linearized FOCs: Households

Back

Search Prices:

$$\hat{\boldsymbol{P}}_{\boldsymbol{S},\boldsymbol{t}} = \epsilon \cdot \hat{\boldsymbol{mc}}_{\boldsymbol{t}} + \frac{\Gamma_S}{1-\phi_\epsilon}\frac{1+\phi_\gamma}{\psi\phi_\gamma}\left(\hat{\boldsymbol{q}}_{\boldsymbol{t}} - \hat{\boldsymbol{\psi}}_{\boldsymbol{t}}\right) - (1+\phi_\gamma)\,\hat{\boldsymbol{\epsilon}}_{\boldsymbol{t}} \tag{23}$$

Price Elasticity of Demand:

$$\hat{\boldsymbol{\Xi}}_{\boldsymbol{t}} = -\phi_\epsilon \hat{\boldsymbol{P}}_{\boldsymbol{S},\boldsymbol{t}} + \hat{\boldsymbol{\epsilon}}_{\boldsymbol{t}} \tag{24}$$

Capacity Utilization:

$$\hat{\boldsymbol{q}}_{\boldsymbol{t}} = \frac{\psi\phi_\gamma}{1+\nu_S}\left[(1-\phi_\epsilon)\,\hat{\boldsymbol{P}}_{\boldsymbol{S},\boldsymbol{t}} - (\nu_S+\phi_C)\,\hat{\boldsymbol{Y}}_{\boldsymbol{t}} - \hat{\boldsymbol{\mu}}_{\boldsymbol{S},\boldsymbol{t}}\right] + (1+\phi_\gamma)\,\hat{\boldsymbol{\psi}}_{\boldsymbol{t}} \tag{25}$$

Consumption Euler Equation:

$$\hat{\boldsymbol{r}}_{\boldsymbol{t}} - \mathbb{E}_t\hat{\boldsymbol{\pi}}_{\boldsymbol{t+1}} = \phi_C\mathbb{E}_t\boldsymbol{\Delta}\hat{\boldsymbol{Y}}_{\boldsymbol{t+1}} + \phi_\epsilon\mathbb{E}_t\boldsymbol{\Delta}\hat{\boldsymbol{P}}_{\boldsymbol{S},\boldsymbol{t+1}} \tag{26}$$

Appendix - Linearized FOCs: Labor Unions & Firms

Back

Posted Price NK Phillips Curve:

$$\hat{\boldsymbol{\pi}}_{\boldsymbol{t}} \;= \frac{1+\phi_\gamma}{\kappa_P}\left[\epsilon\left(1-\phi_\epsilon\right)\hat{\boldsymbol{mc}}_{\boldsymbol{t}} + \frac{\Gamma_S}{\psi}\left(\hat{\boldsymbol{q}}_{\boldsymbol{t}} - \hat{\boldsymbol{\psi}}_{\boldsymbol{t}}\right) - \frac{\hat{\boldsymbol{\epsilon}}_{\boldsymbol{t}}}{\epsilon-1}\right] + \beta\mathbb{E}_t\hat{\boldsymbol{\pi}}_{\boldsymbol{t+1}} \tag{27}$$

Nominal Wage NK Phillips Curve:

$$\hat{\boldsymbol{\pi}}_{\boldsymbol{W,t}} \;= (-1)\frac{\nu_M\left(\epsilon_W-1\right)}{\kappa_W}\phi_u\hat{\boldsymbol{u}}_{\boldsymbol{t}} + \beta\mathbb{E}_t\hat{\boldsymbol{\pi}}_{\boldsymbol{W,t+1}} \tag{28}$$

Real Wage Growth:

$$\hat{\pi}_{W,t} - \hat{\pi}_t = \Delta\hat{mc}_t + \Delta\psi^{-1}\hat{\boldsymbol{q}}_{\boldsymbol{t}} + \Delta\hat{\boldsymbol{A}}_{\boldsymbol{t}} \tag{29}$$

Appendix - Linearized FOCs: General Equilibrium

Back

Real Gross Domestic Product:

$$\hat{\boldsymbol{Y}}_{\boldsymbol{t}} = \nu_M^{-1}\left[(1+\nu_M)\,\hat{\boldsymbol{\tau}}_{\boldsymbol{E,t}} - \hat{\boldsymbol{\tau}}_{\boldsymbol{L,t}}\right] \tag{30}$$

Labor Wedges (following Chari et al. (2007)):

$$\hat{\boldsymbol{\tau}}_{\boldsymbol{L,t}} = \phi_C \hat{\boldsymbol{Y}}_{\boldsymbol{t}} + \nu_M \phi_u \hat{\boldsymbol{u}}_{\boldsymbol{t}} - \hat{\boldsymbol{mc}}_{\boldsymbol{t}} + \phi_\epsilon \hat{\boldsymbol{P}}_{\boldsymbol{S,t}} \tag{31}$$

Efficiency Wedges (following Chari et al. (2007)):

$$\hat{\boldsymbol{\tau}}_{\boldsymbol{E,t}} = \psi^{-1}\hat{\boldsymbol{q}}_{\boldsymbol{t}} + \hat{\boldsymbol{A}}_{\boldsymbol{t}} \tag{32}$$

Appendix: Calibration Targets

Back

Determining the price adjustment cost parameter, κ:

- Values based on Phillips curve estimation using labor share data (Gali & Gertler (1999)):

$$\hat{\pi}_t = \lambda_{ls}\hat{ls}_t + \hat{\xi}_t + \beta\mathbb{E}_t\hat{\pi}_{t+1}$$

- κ_p is set as residual value to match estimated value in the calibrated model.
- Results for default calibration: (1) $\kappa_{NK} \approx 130$, (2) $\kappa_{SaM} \approx 171$.

Determining the output gap Phillips curve slope:

- Output gap can be approximated by labor share: $\tilde{C}_t = \Omega_{ls,NK}^{-1}\hat{ls}_t$.
- Output gap approximation by labor share is biased: $\tilde{C}_t = \Omega_{ls,SaM}^{-1}\left[\hat{ls}_t - \hat{ls}_{N,t}\right]$
- Bias by $\hat{ls}_{N,t}$ is small in goods market SaM model, hence let's ignore it for now.

If $\frac{\Omega_{LS,SaM}}{\Omega_{LS,NK}} \neq 1$, the slopes of the output gap Phillips curves across models are different even though the labor share Phillips curve slopes are identical.

Appendix - Full Steady-State Model

Back

Firm Side:

$$P_S = \frac{\phi_\epsilon}{1-\phi_\epsilon} \tag{33}$$

$$mc = P_S \phi_\gamma^{-1} = \frac{\epsilon - 1}{\epsilon}\left(1 + \frac{\phi_\gamma}{\epsilon}\right)^{-1} \tag{34}$$

$$q = \psi \tag{35}$$

Household Side:

$$\Xi = (-\epsilon)(1-\phi_\epsilon) \tag{36}$$

$$muc = \xi_{C_M}(1-\phi_\epsilon)\, C^{-\sigma} \tag{37}$$

General Equilibrium:

$$Y = C_M = q \cdot \left[\frac{muc}{\mu_M} \cdot \frac{\epsilon_W - 1}{\epsilon_W} \cdot q \cdot mc\right]^{\frac{1}{\nu_M}} \tag{38}$$

Appendix - 5-Equation Reduced-Form Model

Utilization Slope Price Elast. Slope Euler Slope Phillips Slope

$$\begin{aligned}
\hat{\boldsymbol{r}}_t - \hat{\boldsymbol{r}}_t^N - \mathbb{E}_t \hat{\boldsymbol{\pi}}_{t+1} &= \Theta_{\mathbb{M},Y} \mathbb{E}_t \boldsymbol{\Delta} \tilde{\boldsymbol{Y}}_{t+1} + \Theta_{\mathbb{M},u} \mathbb{E}_t \boldsymbol{\Delta} \tilde{\boldsymbol{u}}_{t+1}, && (39) \\
\hat{\boldsymbol{\pi}}_t &= \Theta_{\pi,Y} \tilde{\boldsymbol{Y}}_t + \Theta_{\pi,u} \tilde{\boldsymbol{u}}_t + \beta \mathbb{E}_t \hat{\boldsymbol{\pi}}_{t+1}, && (40) \\
\hat{\boldsymbol{\pi}}_{W,t} &= (-1) \frac{\epsilon_W - 1}{\kappa_W} \phi_u \tilde{\boldsymbol{u}}_t + \beta \mathbb{E}_t \hat{\boldsymbol{\pi}}_{W,t+1}, && (41) \\
\hat{\boldsymbol{\pi}}_{W,t} - \hat{\boldsymbol{\pi}}_t &= \Theta_{w,Y} \boldsymbol{\Delta} \tilde{\boldsymbol{Y}}_t + \Theta_{w,u} \boldsymbol{\Delta} \tilde{\boldsymbol{u}}_t, && (42) \\
\hat{\boldsymbol{r}}_t &= i_r \hat{\boldsymbol{r}}_{t-1} + (1 - i_r) \left[i_\pi \hat{\boldsymbol{\pi}}_t + i_{Gap} \tilde{\boldsymbol{Y}}_t \right] + \hat{\boldsymbol{M}}_t, && (43)
\end{aligned}$$

$\theta_{q,Y} = \theta_{q,q}^{-1} \{\epsilon (1 - \phi_\epsilon) [\nu_M + \phi_C] - (1 - \epsilon\phi_\epsilon) [\nu_S + \phi_C]\}$ and $\theta_{q,u} = \theta_{q,q}^{-1} \epsilon (1 - \phi_\epsilon) \nu_M \phi_u$ with

$\theta_{q,q} = \epsilon (1 - \phi_\epsilon) \left[1 + \nu_M - \frac{\Gamma_S}{1-\phi_\epsilon} \frac{\epsilon - 1}{\epsilon}\right] + \frac{1-\epsilon\phi_\epsilon}{\psi\phi_\gamma} \left[1 + \nu_S - (1 + \phi_\gamma) \Gamma_S\right]$

$\theta_{\Xi,Y} = \frac{\phi_\epsilon}{1-\phi_\epsilon} \left[\nu_S + \phi_C + \frac{1+\nu_S}{\phi_\gamma} \frac{\theta_{q,Y}}{\psi}\right]$ and $\theta_{\Xi,u} = \frac{\phi_\epsilon}{1-\phi_\epsilon} \frac{1+\nu_S}{\phi_\gamma} \frac{\theta_{q,u}}{\psi}$

$\Theta_{\mathbb{M},Y} = \phi_C + \theta_{\Xi,Y}$ and $\Theta_{\mathbb{M},u} = \theta_{\Xi,u}$

$\Theta_{\pi,Y} = \frac{1+\phi_\gamma}{\kappa_P} \left[\frac{1-\phi_\epsilon}{\phi_\epsilon} \theta_{\Xi,Y} - \frac{\Gamma_S}{\phi_\gamma} \frac{\theta_{q,Y}}{\psi}\right]$ and $\Theta_{\pi,u} = \frac{1+\phi_\gamma}{\kappa_P} \left[\frac{1-\phi_\epsilon}{\phi_\epsilon} \theta_{\Xi,u} - \frac{\Gamma_S}{\phi_\gamma} \frac{\theta_{q,u}}{\psi}\right]$

$\Theta_{w,Y} = \frac{\theta_{\Xi,Y}}{\epsilon\phi_\epsilon} + \left(1 - \frac{\Gamma_S}{\epsilon(1-\phi_\epsilon)} \frac{1+\phi_\gamma}{\phi_\gamma}\right) \frac{\theta_{q,Y}}{\psi}$ and $\Theta_{w,u} = \frac{\theta_{\Xi,u}}{\epsilon\phi_\epsilon} + \left(1 - \frac{\Gamma_S}{\epsilon(1-\phi_\epsilon)} \frac{1+\phi_\gamma}{\phi_\gamma}\right) \frac{\theta_{q,u}}{\psi}$

Appendix - Short-Run Equilibrium

Back

The change in the Phillips curve slope is ambiguous:

- If $\frac{\nu_S}{\nu_M} < \bar{\nu}_{SM}$: (Slope $\downarrow$) $\rightarrow$ $(\Delta \tilde{C}_{M,t} = 1\%)$ $\rightarrow$ $(\Delta \hat{\pi}_t \downarrow)$.
- If $\frac{\nu_S}{\nu_M} > \bar{\nu}_{SM}$: (Slope $\uparrow$) $\rightarrow$ $(\Delta \tilde{C}_{M,t} = 1\%)$ $\rightarrow$ $(\Delta \hat{\pi}_t \uparrow)$.

The Euler equation slope is flatter with goods market SaM:

- Real interest rate change leads to lower output gap growth response.

Corollary: Overall Output Gap Response

Goods market SaM impact ...

- **Case 1:** $\frac{\nu_S}{\nu_M} < \bar{\nu}_{SM}$: ... on Phillips & Euler eq. counteract each other.
- **Case 2:** $\frac{\nu_S}{\nu_M} > \bar{\nu}_{SM}$: ... on Phillips & Euler eq. amplify each other.

Appendix - IRFs to Different Expansionary Cost-Push Shocks

Back