Trade Policy Uncertainty and Optimal Monetary Policy

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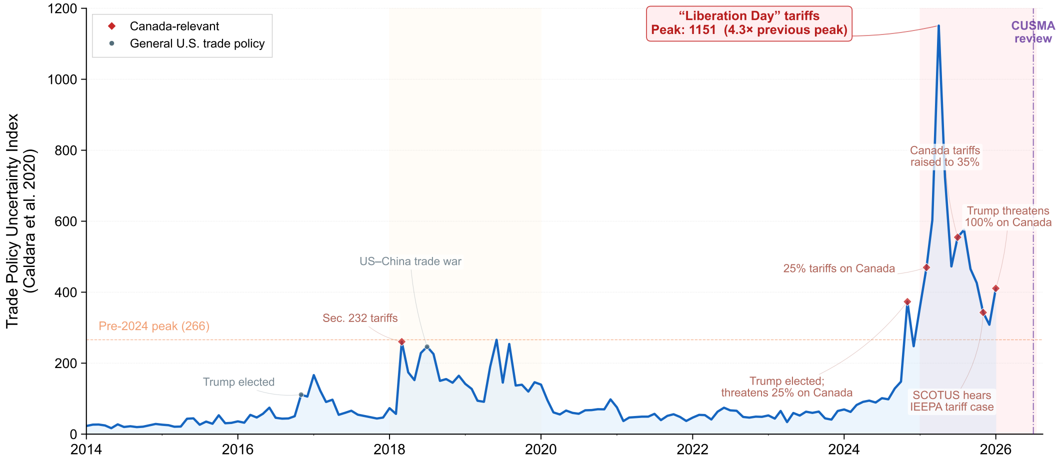
Trade policy has become a prominent source of macroeconomic risk



Key Questions

- How does trade policy uncertainty transmit through the economy?
- What determines the size and direction of the macroeconomic response?
- How does monetary policy affect transmission, and what policy is optimal?

Existing work on uncertainty shocks typically relies on numerical simulations
$\Rightarrow$ limited analytical characterization of transmission and policy

This Paper

Analytically characterize the baseline transmission of export-tariff uncertainty shocks in SOE:

1. **Closed-form IRFs** with two high-order wedges: NKPC vs UIP
   - opposing effects on output: can be either expansionary or contractionary
   - same direction on inflation: large deflationary impacts

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   - strict PPI inflation targeting is optimal
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Implication: Monetary policy shapes the magnitude *and* direction of macro responses to tariff uncertainty shocks.

Model: SOE NK with Tariff Stochastic Volatility

Small open-economy New Keynesian model (*a la* Galí & Monacelli 2005)

- Rotemberg price adjustment costs, producer currency pricing
- Complete international asset markets (incomplete markets as extension)
- Monetary policy: Taylor rule with PPI inflation ($r_t = \phi_\pi \pi_t + \phi_y y_t$), or Ramsey

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Export tariff τ_t with stochastic volatility $\sigma_{T,t}$

$$\tau_t = \rho_\tau \, \tau_{t-1} + e^{\sigma_{T,t-1}} \varepsilon_{\tau,t}$$

$$\sigma_{T,t} = \rho_\sigma \, \sigma_{T,t-1} + \varepsilon_{\sigma,t}$$

- Uncertainty shock $\varepsilon_{\sigma,t}$ moves future $\sigma_{T,t}$, while keeping the level fixed ($\varepsilon_{\tau,t} = 0$)

Calibration Equations

Minimal 2-equation System

- Equilibrium collapses to two forward-looking equations in PPI inflation π_t and the terms of trade q_t ($\uparrow$ means real depreciation)

- Tariff-volatility shocks introduce expectations wedges:

$$\pi_t = \kappa_{mc} mc_t(q_t) + \beta \mathbb{E}_t[\pi_{t+1}] + \Delta_t^{NK} + O(4)$$
$$r_t(\pi_t, q_t) = \mathbb{E}_t\left[(q_{t+1} - q_t) + \pi_{t+1}\right] + \Delta_t^{UIP} + O(4)$$

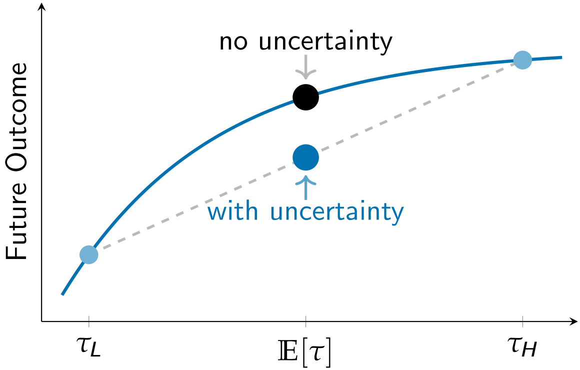
where

$$\Delta_t^{NK} = u^{NK} \sigma_{T,t} + O(4), \qquad \Delta_t^{UIP} = u^{UIP} \sigma_{T,t} + O(4)$$

$\Rightarrow$ Baseline signs: ($u^{NK} < 0$, $u^{UIP} < 0$); two wedge loadings

Lemma 1

Intuition: Why Wedges Arise and What They Depend On



- Uncertainty alters expected values of future outcomes (e.g. $\mathbb{E}[\pi_{t+1}]$ and $\mathbb{E}[q_{t+1}]$)
- In general, the sign of the wedge depends on the distribution of future outcomes (e.g. whether it is convex or concave in tariff states)

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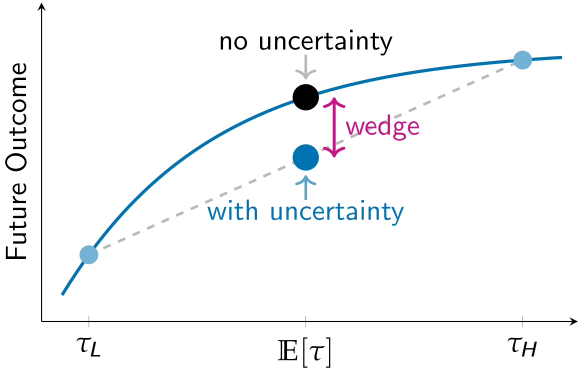

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Pricing Wedge u^{NK}

How does tariff risk affect pricing incentives?

$$u^{NK} \propto \underbrace{3A_\pi^2}_{\text{Rotemberg cost} > 0} + \underbrace{2A_\pi s}_{\text{Covariance} < 0} + \underbrace{B_\pi}_{\text{Curvature} < 0}$$

where

- $A_\pi > 0$ and $B_\pi < 0$ govern the response of inflation to a tariff **level** shock:

$$\pi_t = A_\pi \tau_t + \frac{1}{2} B_\pi \tau_t^2$$

- $A_\pi s$ captures how inflation co-variates with discount factor s

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- Risk creates inflation dispersion, raising expected adjustment costs

Wedge Sensitivity

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Intuition:

- Risk creates inflation dispersion, raising expected adjustment costs
- Low tariffs mean high sales, so price deviations matter more there

⇒ Firms weight low-tariff states more, pulling prices down; concavity reinforces this

Wedge Sensitivity

UIP / Risk-Premium Wedge u^{UIP}

How does tariff risk affect exchange rates?

$$u^{UIP} \propto \underbrace{-(A_\pi + A_q)^2}_{\text{Variance } < 0} + \underbrace{(B_\pi + B_q)}_{\text{Curvature } < 0}$$

where (A_π, B_π) and (A_q, B_q) govern the responses of inflation and the terms of trade to tariff **level** shocks:

$$\pi_t = A_\pi \tau_t + \tfrac{1}{2} B_\pi \tau_t^2 \quad \text{and} \quad q_t = A_q \tau_t + \tfrac{1}{2} B_q \tau_t^2$$

Intuition:

$\Rightarrow$ Tariff risk increases uncertainty about future exchange rates

$\Rightarrow$ Foreign-currency assets become riskier in home-currency terms

$\Rightarrow$ Appreciation of home currency today to raise expected return

Wedge Sensitivity

Closed-Form Uncertainty Responses

IRFs to tariff uncertainty shock:

$$\pi_t = \rho_\sigma^t \chi_\pi, \qquad q_t = \rho_\sigma^t \chi_q, \qquad y_t = \theta_q q_t,$$

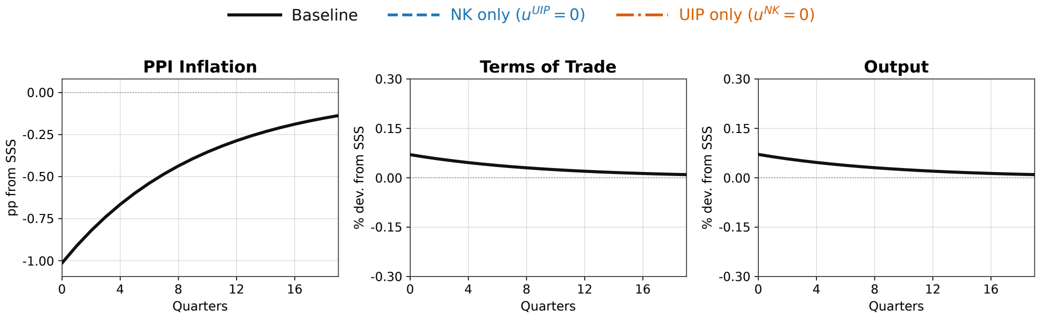
where ρ_σ is persistence of uncertainty shock and

$$\chi_\pi \propto \overbrace{(\phi_y \theta_q + 1 - \rho_\sigma) u^{NK}}^{(-)} + \overbrace{\tilde{\kappa}\, u^{UIP}}^{(-)} \qquad \chi_q \propto \overbrace{-(\phi_\pi - \rho_\sigma) u^{NK}}^{(+)} + \overbrace{(1 - \beta\rho_\sigma) u^{UIP}}^{(-)}$$

- $\theta_q \approx 1$ under baseline calibration
- ϕ_π and ϕ_y are Taylor rule parameters for inflation and output

Responses to Export Tariff Uncertainty

Shock: doubling tariff volatility



- Large deflationary effects, but small impacts on terms of trade and output

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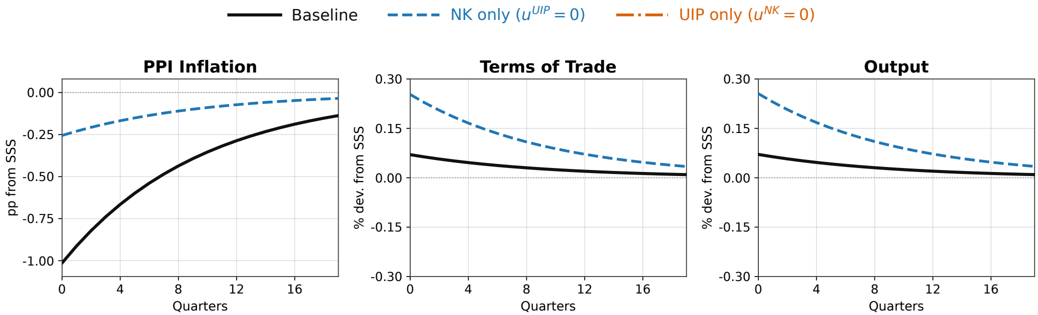

- NKPC-only: deflation triggers easing, real depreciation and higher output

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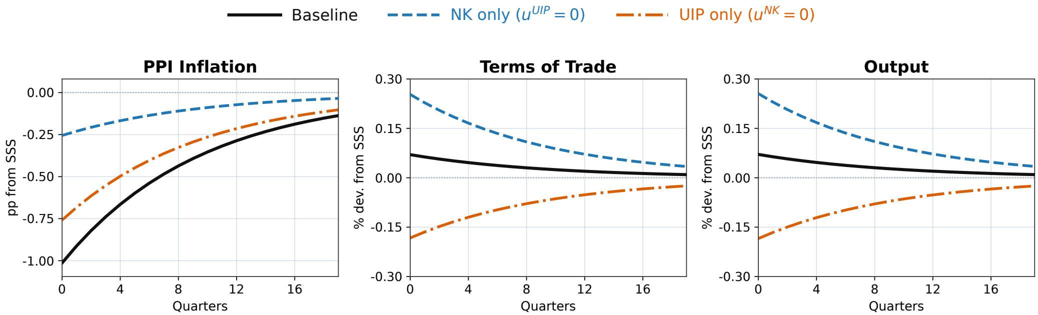

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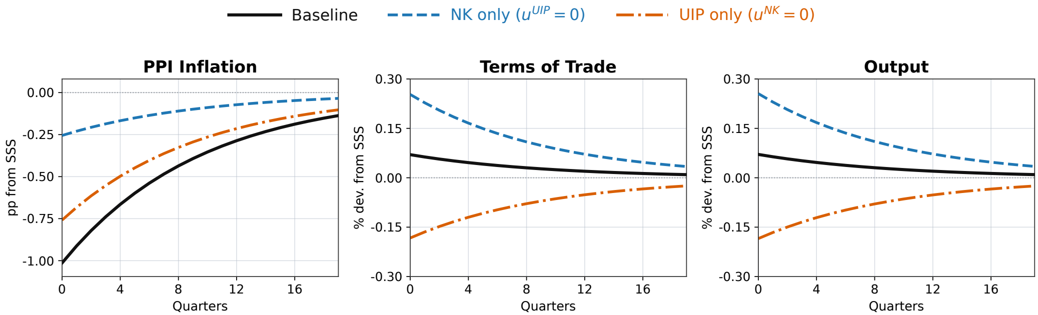
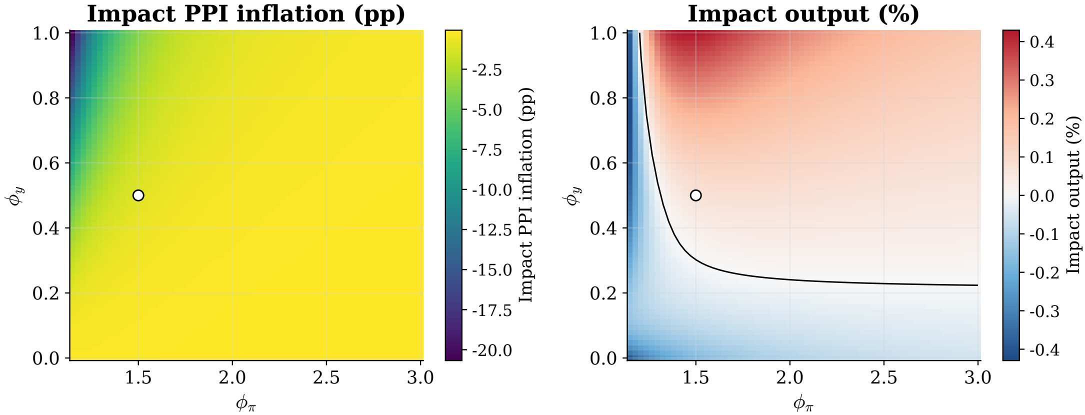


- NKPC-only: deflation triggers easing, real depreciation and higher output
- UIP-only: asset-pricing effects drive appreciation and lower output
- Together: both channels are deflationary, but they offset on the real side

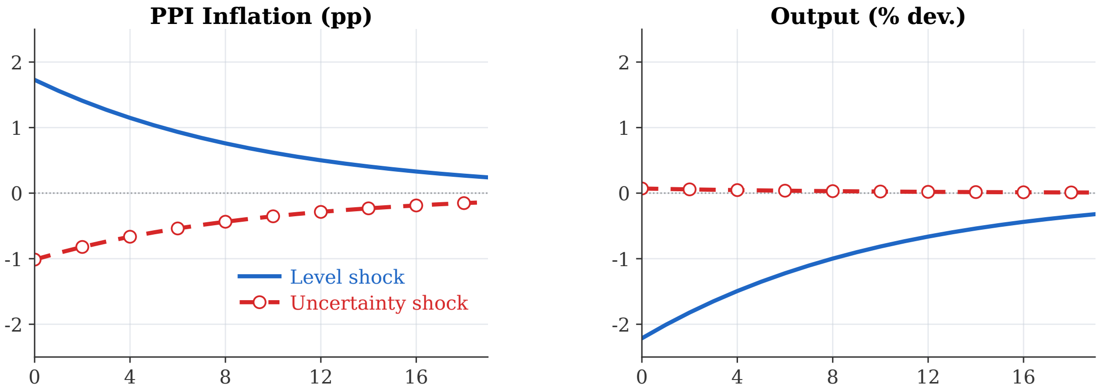
Uncertainty shocks can be expansionary or contractionary depending on monetary policy



- Contractionary when monetary policy looks through uncertainty shocks (low φ_π or φ_y)

Opposite Effects of Level vs Uncertainty Shocks

Responses to a 10% rise in export tariffs versus a doubling of tariff uncertainty



- Uncertainty can dampen the effects of level shocks

Sign Regions
All Variables

Optimal Ramsey Policy

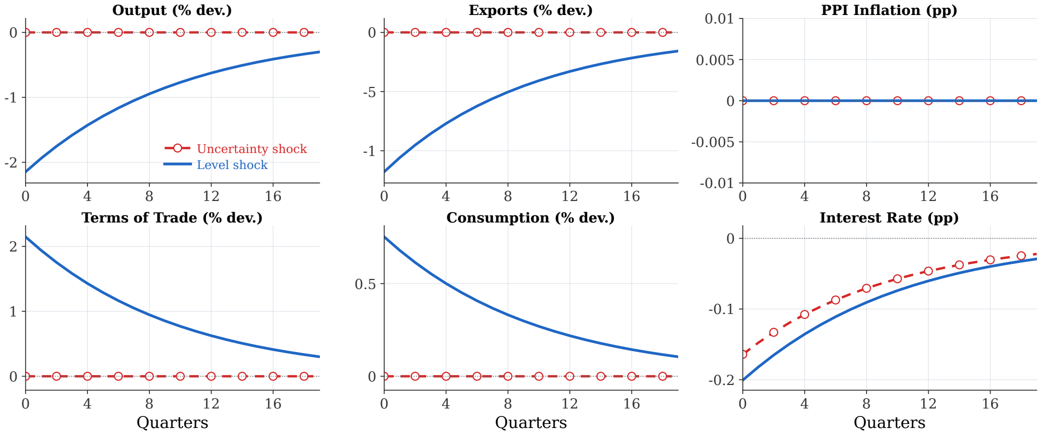
Divine coincidence for tariff uncertainty

Under complete markets with producer currency pricing, strict PPI inflation targeting ($\pi_{H,t} = 0 \; \forall t$) is Ramsey optimal and makes real effects of uncertainty shocks $O(4)$.

- Strict PPI inflation targeting fully stabilizes current and future prices $\pi_{H,t} = 0$, which eliminates price-adjustment frictions and hence output gap $\tilde{y}_t = 0$
- Benchmark flexible-price allocation depends on tariff *levels*, not volatility
- UIP wedge adjusts the interest rate, leaving real allocations unaffected

Same Optimal Policy, Different Macro Responses

Responses to tariff level vs uncertainty shocks under strict PPI targeting



- Optimal policy implies full stabilization of uncertainty shocks, while output falls under level shocks.

Alternative Rules

Conclusion

Study the baseline transmission of export-tariff uncertainty shocks in SOE:

1. **Two-wedge system**: NKPC + UIP pin down uncertainty IRFs

   ⇒ small output effects but large deflationary impacts

   ⇒ uncertainty can dampen the effects of level shocks

2. **Optimal policy**: Complete market ⇒ strict PPI targeting

Implication: Monetary policy plays a crucial role in shaping both magnitude and direction of macro responses to uncertainty shocks

Appendix

A1: Baseline Calibration

Parameter	Description	Value
β	Discount factor	0.99
σ	Risk aversion	2
φ	Inverse Frisch elasticity	1
α	Import share (openness)	0.30
γ	Trade elasticity (Armington)	1.5
ε	Elasticity of substitution	10
κ	Rotemberg adjustment cost	40
ϕ_π	Taylor rule: inflation	1.5
ϕ_y	Taylor rule: output gap	0.5
ρ_τ	Tariff persistence	0.9
$\bar{\sigma}_\tau$	Steady-state tariff volatility	0.10
ρ_σ	Volatility persistence	0.9
η_σ	Volatility shock size	$\log 2 \approx 0.693$

Model

A2: Key Equilibrium Conditions

NKPC: $\kappa(\Pi_{H,t} - 1)\Pi_{H,t} = (\varepsilon - 1)(mc_t - 1) + \beta\kappa\, \mathbb{E}_t\left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}(\Pi_{H,t+1} - 1)\Pi_{H,t+1}\frac{Y_{t+1}}{Y_t}\right]$

UIP: $\mathbb{E}_t\left[\beta\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{Q_t}{Q_{t+1}}\frac{1 + r_t}{1 + \pi_{C,t+1}}\right] = 1$

Taylor: $1 + r_t = \beta^{-1}(1 + \pi_{H,t})^{\phi_\pi}\left(\frac{Y_t}{Y_{ss}}\right)^{\phi_y}$

Tariff SV: $\tau_t = \rho_\tau\tau_{t-1} + \bar{\sigma}_\tau e^{\sigma_{T,t-1}}\varepsilon_{\tau,t}, \quad \sigma_{T,t} = \rho_\sigma\sigma_{T,t-1} + \eta_\sigma\varepsilon_{\sigma,t}$

Model

Lemma 1: Exact Nonlinear 2×2 System

Under CM + PCP + risk sharing, equilibrium reduces to two equations in $(\Pi_{H,t}, Q_t)$:

$$\kappa(\Pi_{H,t}-1)\Pi_{H,t} = (\epsilon-1)(mc_t-1) + \beta\kappa\mathbb{E}_t\left[(\Pi_{H,t+1}-1)\Pi_{H,t+1}\frac{Y_{t+1}}{Y_t}\frac{Q_t}{Q_{t+1}}\right]$$

$$1 = \Pi_{H,t}^{\phi_\pi}\left(\frac{Y_t}{\bar{Y}}\right)^{\phi_y} e^{\psi_t}\mathbb{E}_t\left[\frac{Q_t}{Q_{t+1}\Pi_{H,t+1}}\right]$$

- Output and marginal cost are **static functions** of $(\Pi_{H,t}, Q_t, \tau_t)$
- Risk sharing: $C_t = (G_t / Q_t)^{-1/\sigma}$ eliminates Euler equation

System

The $\mathbf{M}(\rho)$ Template and Static Elasticities

All three coefficient layers solve a 2×2 linear system with the **same matrix**:

$$\mathbf{M}(\rho) \equiv \begin{pmatrix} 1 - \beta\rho & -\tilde{\kappa} \\ \phi_\pi - \rho & \phi_y \theta_q + 1 - \rho \end{pmatrix}, \qquad \tilde{\kappa} \equiv \kappa_{mc}(1 + \varphi\theta_q)$$

Three layers, one template:

- (A_π, A_q): first-order tariff $\rightarrow$ $\mathbf{M}(\rho_\tau)$
- (B_π, B_q): second-order curvature $\rightarrow$ $\mathbf{M}(\rho_\tau^2)$
- (χ_π, χ_q): uncertainty $\rightarrow$ $\mathbf{M}(\rho_\sigma)$

Static elasticities:

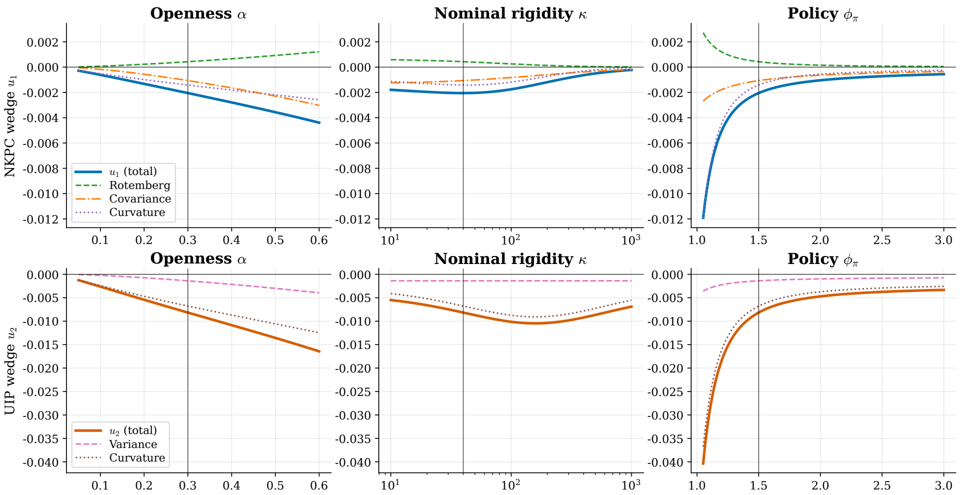
$$\theta_q = (1-\alpha)\left[\tfrac{1}{\sigma} + \alpha\left(\gamma - \tfrac{1}{\sigma}\right)\right] + \alpha\gamma$$

$$\theta_\tau = \alpha\gamma$$

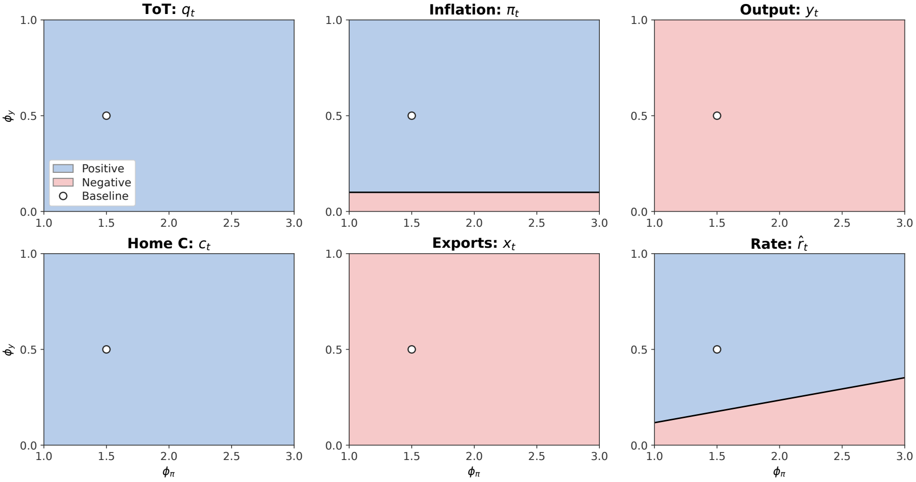
$$\kappa_{mc} = (\epsilon - 1)/\kappa$$

System

Wedge Component Sensitivity

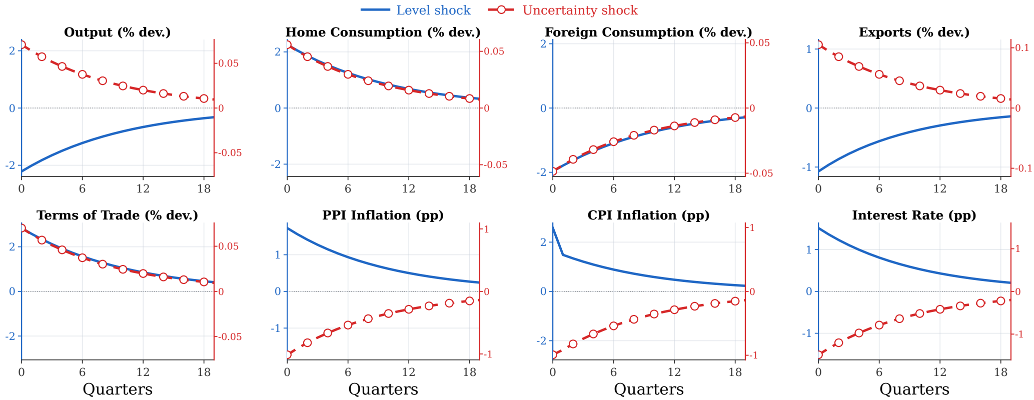


Level-Shock Sign Regions



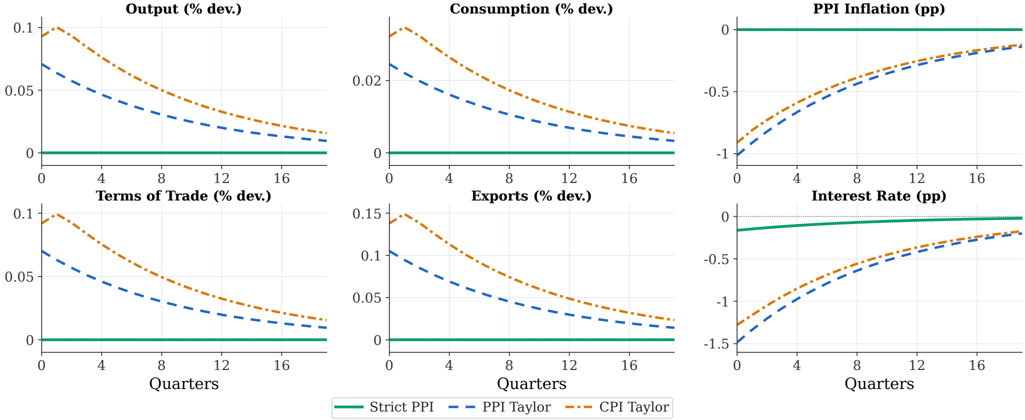
Opposite Responses

All Variables: Level vs Uncertainty



Opposite Responses

Responses to Tariff Uncertainty Shock under Alternative MP Rules



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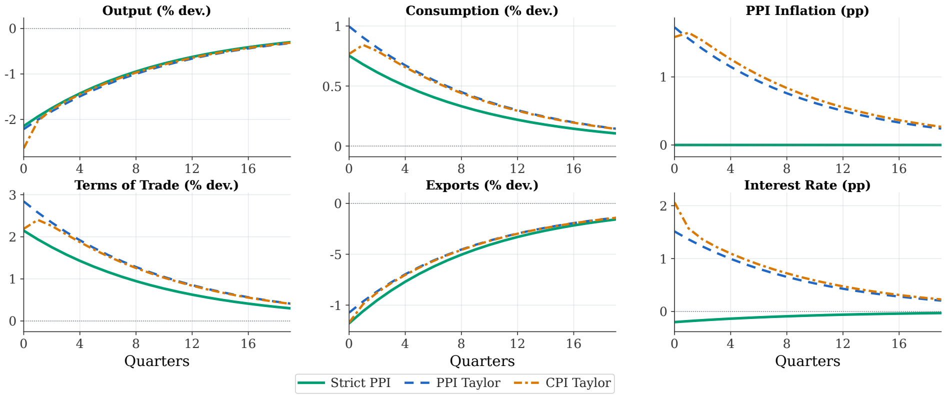
Policy Comparison: Tariff Level Shock



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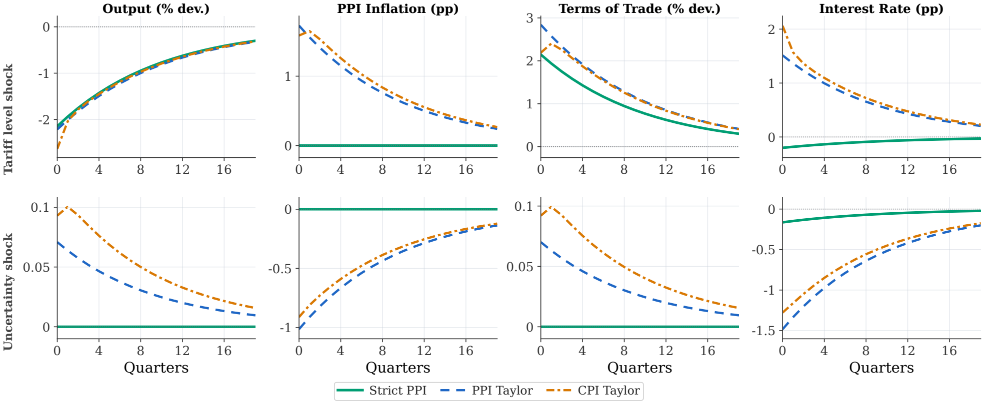
Policy Comparison: Level and Uncertainty



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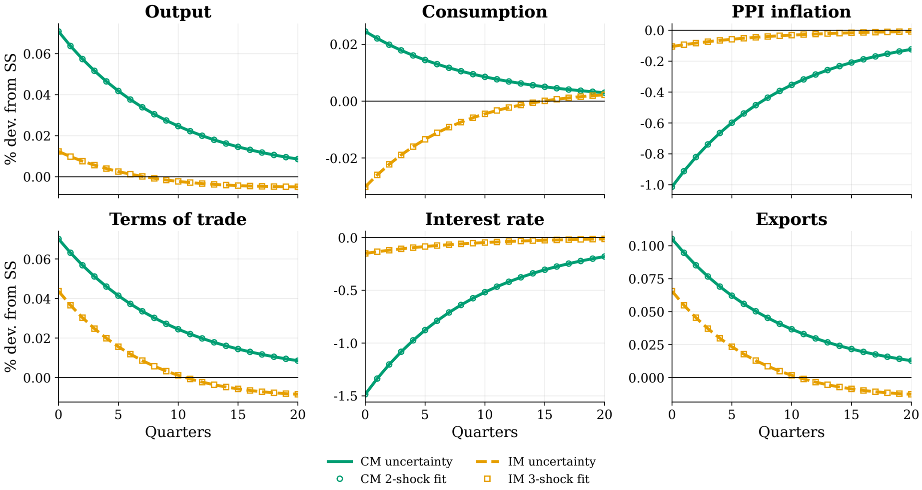
Incomplete Markets: Precautionary-savings Channel

Without risk sharing, the Euler equation gives rise to the *precautionary-savings channel*:

$$\hat{c}_t = \mathbb{E}_t[\hat{c}_{t+1}] - \frac{1}{\sigma}\left(\hat{r}_t - \mathbb{E}_t[\hat{\pi}_{C,t+1}]\right) - \frac{1}{\sigma}\widetilde{\Delta}_t^E + O(4)$$

- Euler/Jensen wedge: $\widetilde{\Delta}_t^E \propto \bar{\sigma}_\tau^2 \left(e^{2\sigma_{T,t}} - 1\right)$
- 3×3 system: NKPC + UIP + Euler
- Divine coincidence **breaks**: PPI targeting $\not\Rightarrow$ $\tilde{y}_t = 0$ generically

Responses to Uncertainty Shocks: CM vs IM



Two-Channel Spanning (Proposition 2)

Can the responses to tariff uncertainty be mimicked by classical first-order shocks?

- With common shock persistence ρ, responses to tariff uncertainty can be mapped to responses to productivity shock and risk-premium shock with fixed weights

$$\mathrm{IRF}_t^{\mathrm{unc}}(x) = \lambda_A \, \mathrm{IRF}_t^{\mathrm{Prod}}(x) + \lambda_\psi \, \mathrm{IRF}_t^{\psi}(x) + O(4)$$

where

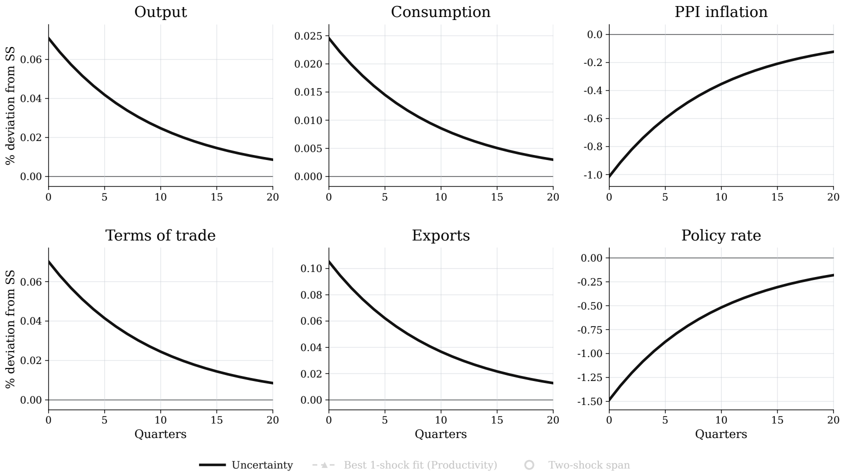
$$\lambda_A = \eta_\sigma \frac{\tilde{\kappa}\chi_q - (1-\beta\rho)\chi_\pi}{\sigma_A \, c_a}, \qquad c_a \equiv \kappa_{mc}(1+\varphi)$$

$$\lambda_\psi = \eta_\sigma \frac{-(\phi_y\theta_q + 1 - \rho)\chi_q - (\phi_\pi - \rho)\chi_\pi}{\sigma_\psi}$$

- Baseline: $\lambda_A = 0.316$, $\lambda_\psi = 0.566$

Spanning Weights | Two-shock IRFs

Two Shocks Are Necessary and Sufficient



Spanning Spanning Weights

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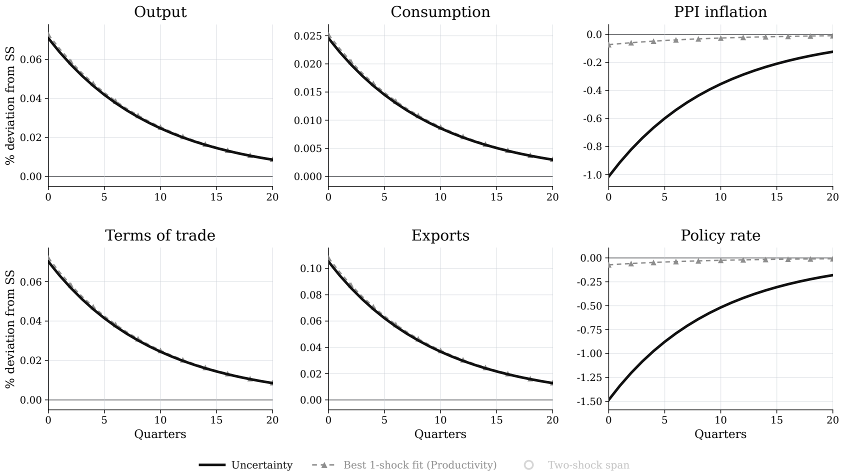

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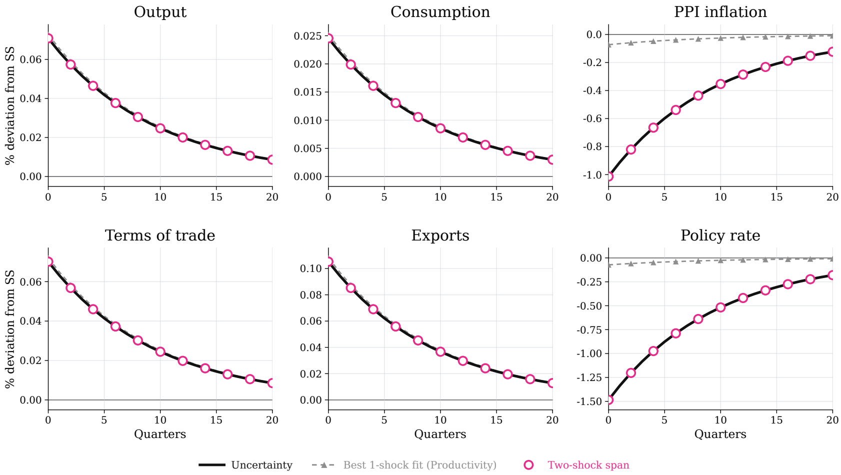
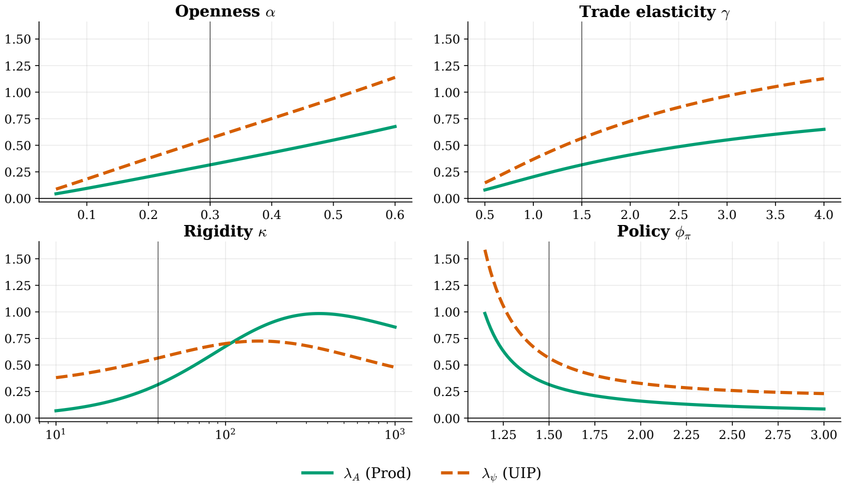


Spanning Weights Sensitivity



Spanning