Tariffs and Retaliation:
A Macroeconomic Analysis

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Introduction

- ▶ The new world of trade policy - large unilateral tariffs imposed by US on all trade partners

- ▶ Large debate about their macro impact on inflation, output, trade balance etc..

- ▶ This paper explores impact of tariff shocks in small quantitative model of a global economy

- ▶ Allow for variety of assumptions about trade linkages, economic policy, financial market structure, nominal rigidities, etc?

- ▶ Are there a general predictions across all specifications?
    - ▶ Look at both unilateral tariffs and retaliation

- ▶ Using a small scale NK model, calibrating to US versus ROW

Description of basic model

- Two country - US (Foreign) and ROW (Home)

- A New Keynesian framework with sticky prices (PCP in baseline)

- Trade in intermediate inputs, investment and capital accumulation, incomplete financial markets

- Monetary policy targets CPI inflation rate

- Many extensions and alternative calibrations

Questions

- What are the short run and long run macro responses to tariff shocks?
- Does a tariff improve the trade balance?
- How is the burden of tariffs spread across countries?
- How does retaliation change the answers?
- Are the predictions consistent across specifications?

Quick preview of results

- ▶ Details matter, especially for short run impacts of tariffs

  - ▶ Start at a of 3 percent, then raise tariff by 10 percent across the board

  - ▶ In baseline case, US output falls by 1.5 percent and converges to lower steady state level

  - ▶ In baseline trade balance deteriorates on impact

  - ▶ US welfare increases with a unilateral tariff, but US loses more in a trade war

- ▶ Departing from baseline can change results significantly

- ▶ Key features of response:

  - (a) Asymmetries in size - US is small relative to the rest of the world
  - (b) Type of nominal rigidities (currency of trade pricing) and monetary policy stance play a large role in short run effects
  - (c) Intermediate imported inputs & trade elasticities are quantitatively very important
  - (d) Financial market structure has big affect on both short run and long run response.

Literature review

- **Open economy macro literature** Corsetti and Pesenti (2001), Benigno and Benigno (2003), Galì and Monacelli (2005), Faia and Monacelli (2008), de Paoli (2009), Costinot et al. (2014), Bhattarai and Egorov (2016), Groll and Monacelli (2020), Fujiwara and Wang (2017), Egorov and Mukhin (2023).

- **Optimal Tariffs and Retaliation** Bagwell and Staiger (2016), Caliendo and Parro (2021), Johnson (1953), Kennan and Riezman (1988), Syropoulos (2002), Gros (1987), Opp (2010), Felbermayr et al. (2013)

- **Quantitative assessment of trade wars** Perroni and Whalley (2000), Ossa (2011), Broda et al. (2008) Ossa (2014), Lashkaripour (2021), Fajgelbaum and Khandelwal (2022)

- **Recent papers on trade policy and monetary policy** Barattieri et al. (2021), Erceg et al. (2023), Furceri et al. (2018), Lindé and Pescatori (2019), Bergin and Corsetti (2020a), Jeanne (2021), Bergin and Corsetti (2020b), Caballero et al. (2015), Lechthaler (2017), **?**, Bianchi Coulibaly (2025), Auclert et al. (2025), Guerrieri et al. (2025), Idnatenko et al. (2025), Monacelli (2025), Alessandria et al. (2025), Costinot and Werning (2025)

Roadmap

1. Basic model
2. Special case with analytical solution
3. Impact of US tariff shock
4. Retaliation
5. Extensions
   (i) Traded goods pricing
   (ii) Monetary policy response
   (iii) Trade elasticities
   (iv) Intermediate inputs
   (v) Financial markets

Basic Model

- ▶ Home and Foreign, supposed to represent the rest of the world (ROW) and US

- ▶ Households supply labor and consume goods from both countries, as well as saving in bonds and physical capital which is rented to firms

- ▶ Home has share n of these, with Foreign share $1 - n$.

- ▶ Firms use a combination of labor, capital and intermediate goods

- ▶ Capital mobility with bond trade - trade only in one period nominal bond

Households

- Home household maximizes its welfare index:

$$\mathbb{E}_t \sum_{s=0}^{\infty} \beta^s \left(\frac{C_{t+s}^{1-\sigma}}{1-\sigma} - \frac{H_{t+s}^{1+\psi}}{1+\psi} \right),$$

- With budget constraint:

$$S_t F_t + B_t + P_{ht} \left(C_{ht} + I_{ht} \right) + \left(1 + \tau_t \right) S_t P_{ft}^* \left(C_{ft} + I_{ft} \right) + P_t \Lambda_t^f$$

$$= S_t F_{t-1} R_{t-1}^* + B_{t-1} R_{t-1} + R_t^k K_{t-1} + W_t H_t + \Pi_t + TR_t$$

- Three types of assets - home and foreign currency short term bonds, and capital

- Adjustment costs of investment in capital:

$$K_t = \left(1 - \delta \right) K_{t-1} + I_t \left(1 - \varphi \left(I_t / I_{t-1} - 1 \right)^2 / 2 \right)$$

- US imports subject to a tariff τ_t

- Tariff revenue rebated to households lump-sum

Consumption, price index

- Home consumption:

$$C_t = \left(\gamma^{1/\lambda} C_{ht}^{1-1/\lambda} + (1-\gamma)^{1/\lambda} C_{ft}^{1-1/\lambda} \right)^{\frac{1}{1-1/\lambda}},$$

  where $\gamma = n + x\,(1-n)$, and x denotes Home bias.

- Price index (Tariff directly enters CPI):

$$P_t = \left(\gamma P_{ht}^{1-\lambda} + (1-\gamma)\left((1+\tau_t)\,S_t P_{ft}^*\right)^{1-\lambda} \right)^{\frac{1}{1-\lambda}},$$

Firms

- The production function for firm i in the Home country is:

$$Y_t(i) = A_t \left(K_{t-1}(i)^\alpha H_t(i)^{1-\alpha} \right)^{1-\eta} X_t(i)^\eta, \qquad (1)$$

- Intermediate good inputs are composed of Home and Foreign goods

$$X_t(i) = \left(\gamma_x^{\frac{1}{\lambda}} X_{ht}(i)^{\frac{\lambda-1}{\lambda}} + (1-\gamma_x)^{\frac{1}{\lambda}} X_{ft}(i)^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}},$$

- where $X_{jt}(i)$ is the Home firm's use of inputs from country $j = \{h, f\}$,

Monetary policy rules target CPI

- Allowing for interest rate smoothing

$$\log(R_t\beta) \quad = \quad \rho_r \log(R_{t-1}\beta) + (1 - \rho_r)\mu \log(\tilde{\pi}_t),$$

$$\log(R_t^*\beta) \quad = \quad \rho_r \log(R_{t-1}^*\beta) + (1 - \rho_r)\mu \log(\tilde{\pi}_t^*),$$

- We look at various alternatives to this (PPI targeting, Output gap inclusion)

Now take a special case of the model – Small Open Economy

- Preferences
$$U = \log C - \frac{H^2}{2}$$

- World demand for its export good with elasticity ζ
$$C_{h,f}^* = \Lambda \left(\frac{P_{h,t}}{S_t} \right)^{-\zeta} \tag{2}$$

- One-period ahead price setting, no investment or capital accumulation.
- Domestic elasticity of substitution is λ
- At time $t = 0$: a permanent, unanticipated tariff shock.
- Prices fully adjust after one period
- So we effectively have a two period model

Long run response - domestic versus foreign elasticities

- Tariff reduces gross output Y and GDP (H_t)

$$\hat{Y}_t = -\frac{(4\zeta + \lambda - 2)}{2(2\zeta + \lambda)}d\tau \qquad \hat{H}_t = -\frac{1}{2}d\tau$$

  - Long run fall in GDP (due to reduced labor supply)
- Terms of trade appreciation

$$\hat{\mathcal{S}}_t = -\frac{(\lambda + 2)}{2\zeta + \lambda}d\tau$$

.

- Aggregate consumption

$$\hat{C}_t = -\frac{(2\zeta - \lambda - 4)}{2(2\zeta + \lambda)}d\tau$$

- Low λ implies larger fall in output, less improvement in the terms of trade, and more likely to have a fall in aggregate consumption
- Low ζ has the opposite effects

Long run response

▶ Nominal exchange rate appreciates but by less than the tariff

$$\hat{S}_t = -d\tau + \frac{(\zeta - 1))}{(2\zeta + \lambda)}d\tau$$

▶ While aggregate consumption may fall, welfare increases starting from a zero tariff

$$dU = \frac{\lambda + 2}{(2\zeta + \lambda)} > 0$$

▶ Given full adjustment and a permanent tariff, $dTB = 0$, no change in the trade balance

Response in short run

- P_{h0} is fixed, so CPI stabilization $\implies$ exchange rate appreciates by the size of the tariff shock

$$\hat{S}_0 = -d\tau \quad < \hat{S}_t$$

- Exchange rate appreciation exactly offsets the tariff and so eliminates expenditure switching - GDP falls more in the short run

$$\hat{Y}_0 = \hat{Y}_t - \frac{2(\zeta - 1)}{3}d\tau \quad < \hat{Y}_t$$

- Trade balance deteriorates: No expenditure switching away from imports, while export demand falls

$$dTB = -\frac{(4\zeta(\zeta - 1) + \lambda 2(\zeta + 1) + 6)}{6(2\zeta + \lambda)}d\tau < 0$$

.

But with LCP we get the opposite results!

- With LCP, P_{h0} and P_{f0} fixed in dollars, but the tariff falls on top of fixed foreign price

- Tariff increases aggregate demand - expenditure switching from imports towards domestic goods.

- Exchange rate appreciation has no effect on foreign export demand or home import demand

- GDP rises in the short run

$$\hat{Y}_0 = \frac{2\zeta(\lambda - 1) + \lambda(1 + \lambda) + 4}{6(2\zeta + \lambda)} d\tau > 0$$

- Trade balance improves (exports unchanged while imports fall)

$$dTB = \frac{(\lambda + 2)(\lambda + 2\zeta - 4)}{12(2\zeta + \lambda)} > 0$$

- Long run response the same as before

The Main model: Calibration

- Quarterly frequency. Home = ROW Foreign = US.

- US is calibrated using the relative population of the US, $1 - n = 0.083$

- Trade openness of 0.25 in the US

- ROW has much lower trade openness with the US under 3 percent

- Trade elasticity is $\lambda = 5$

- Rotemberg parameter is $\phi = 100$, with PCP pricing in baseline

- Share of intermediate goods in production to be $\alpha = 0.4$.

- Capital share in value added $\alpha = 0.36$, depreciation rate $\delta = 0.25$, investment adjustment cost $\varphi = 2.57$

- US relative GDP $A^*/A = 1.987$.

- The persistence of the monetary policy rules is $\rho_r = 0.8$ and the response to annual CPI inflation is $\mu_\pi = 1.5$, in line with empirical estimates.

Table 1: Baseline parameter values.

Parameter (description)	Value	Target or Source
Households		
β (discount factor)	0.99	4% annual real interest rate
σ (risk aversion)	1.5	Standard value
ψ^{-1} (Frisch elasticity)	0.4	Chetty et al. (2011)
δ (capital depreciation rate)	0.025	Quarterly value
φ (inv. adjustment cost)	2.75	Matches $\sigma_I/\sigma_Y = 3$
$1 - n$ (US share of world pop.)	0.083	Auray, Devereux, and Eyquem (2025b)
Trade and Financial Markets		
x (home bias)	0.665	Matches US trade openness (25%)
τ, τ^* (initial US and RoW tariff)	0.03	Pre-shock level
γ (US import share in CES)	0.6928	Derived from x and τ
γ^* (RoW import share in CES)	0.9722	Implied from CES bundles
λ (trade elasticity)	5	Imbs and Mejean (2017)
ν (bond adjustment cost)	0.0025	Ghironi and Melitz (2005)
Firms		
ϵ (substitution elasticity)	6	Implies 20% markup
ϕ (Rotemberg cost)	100	Matches Phillips curve slope of 0.06
α (capital share)	0.36	Standard value
η (share of intermediates)	0.4	Bergin and Corsetti (2023)
A^*/A (US relative TFP)	1.987	Auray, Devereux, and Eyquem (2025b)
Monetary Policy		
ρ_r (policy inertia)	0.8	Standard Taylor rule persistence
μ_π (inflation response)	1.5	Standard rule coefficient

Main Model: Baseline results with exogenous tariffs

- ▶ Take an unanticipated, permanent rise in US tariffs on Foreign goods by 10 percent against all trading partners. Non-linear perfect foresight solution.

- ▶ Tariff leads to large rise in the cost of imported consumption goods and intermediate inputs

- ▶ Effects depend on many assumptions including trade elasticity, traded goods pricing, share of imported intermediate goods, monetary policy response, financial market structure
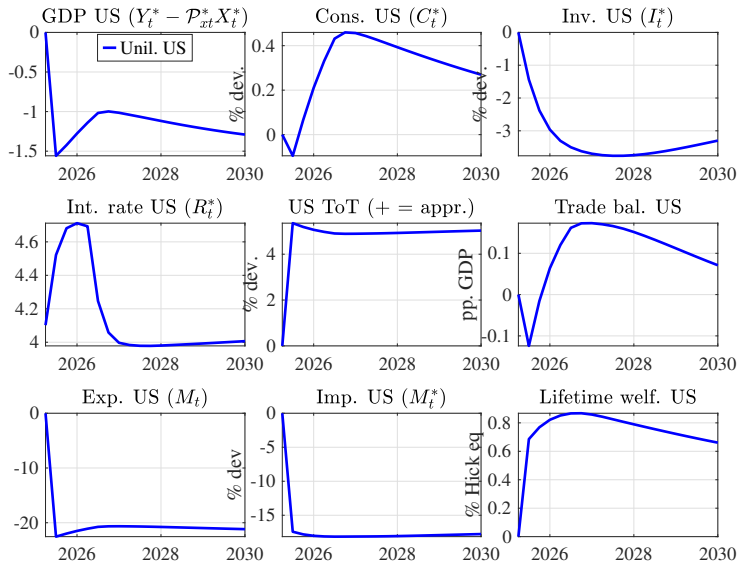
Terms of trade

▶ Terms of trade appreciates by 5% - fall in world price of imports
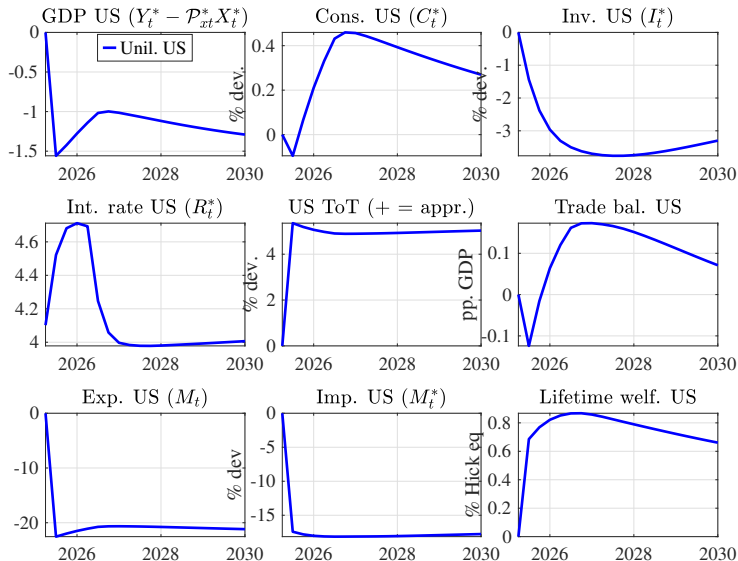
Policy interest rate

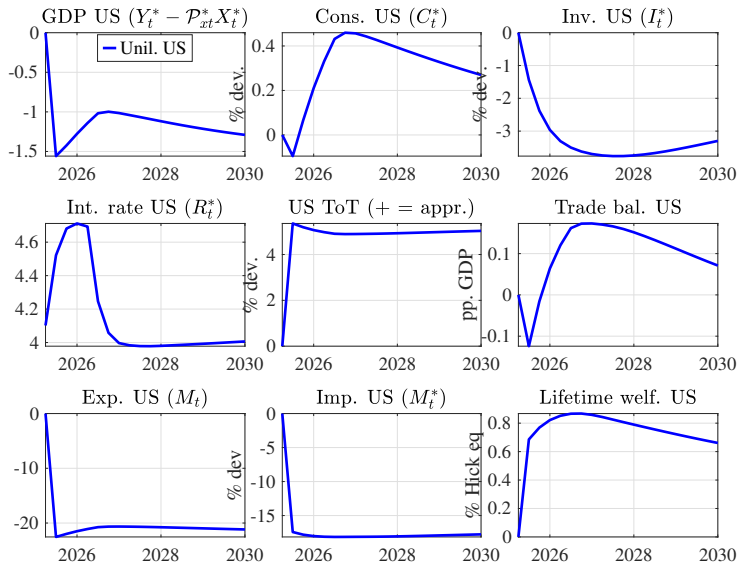- Rise in CPI leads to a rise in policy interest rate by 60 bp

Domestic Consumption and Investment

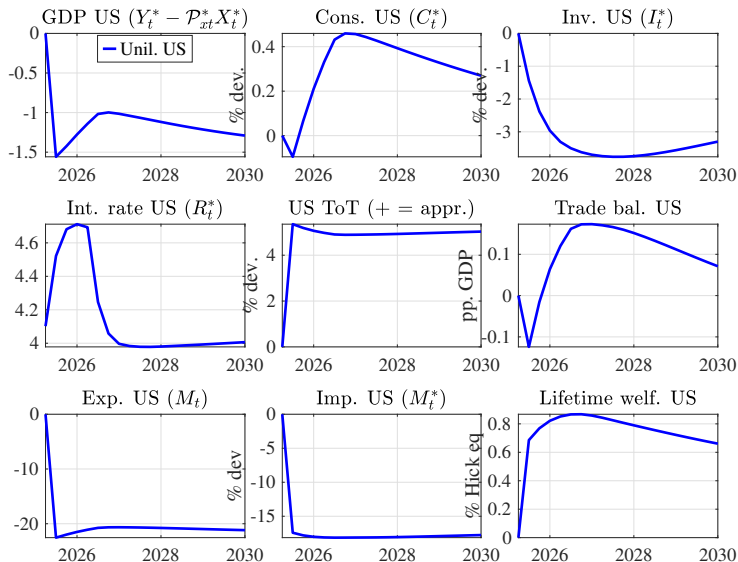▶ Consumption higher and Investment lower
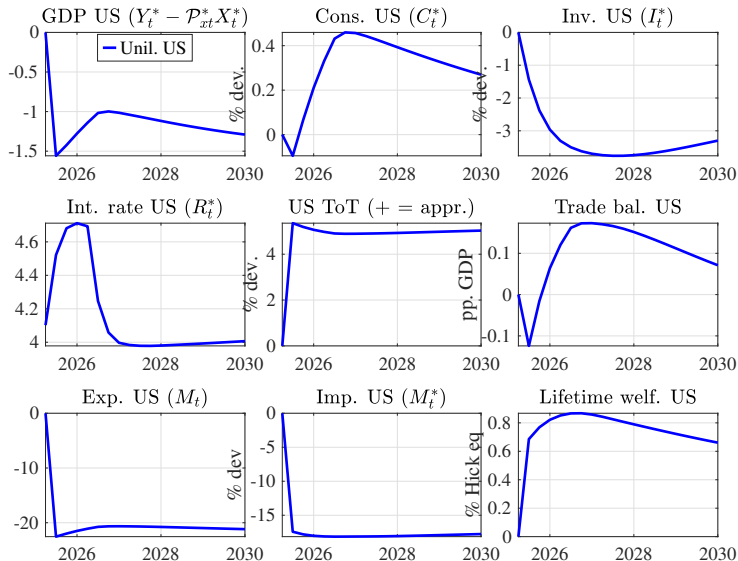
GDP, Trade Balance

▶ GDP falls by 1.5% and trade balance falls on impact

Welfare gains

- Welfare higher due to lower labor supply and improved terms of trade

GDP US ($Y_t^* - \mathcal{P}_{xt}^* X_t^*$), Cons. US ($C_t^*$), Inv. US ($I_t^*$), Int. rate US ($R_t^*$), US ToT (+ = appr.), Trade bal. US, Exp. US (M_t), Imp. US (M_t^*), Lifetime welf. US — Unil. US

ROW loses

- ROW inflation and policy rate rise
- But ROW output and consumption falls much less than US
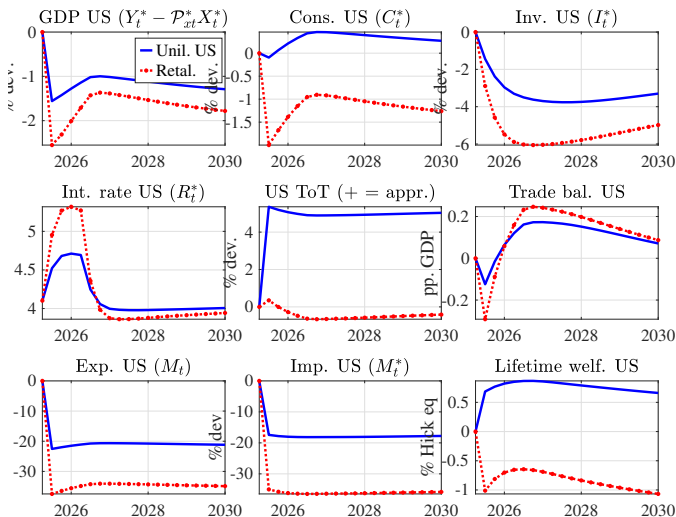- Consumption and welfare permanently lower
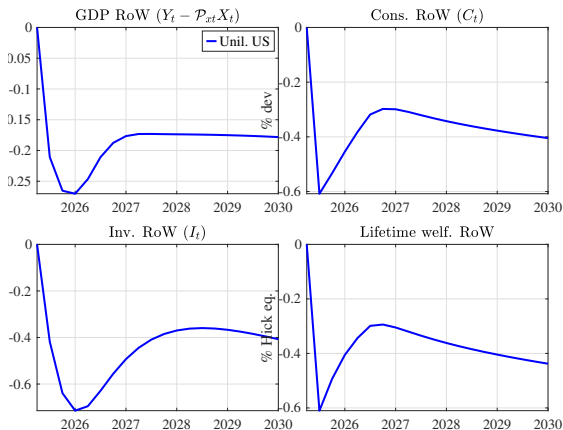
Retaliation - ROW tariff matches US one for one

- US Terms of Trade appreciation almost eliminated
- US CPI rises by much more, leading to a larger rise in policy rate
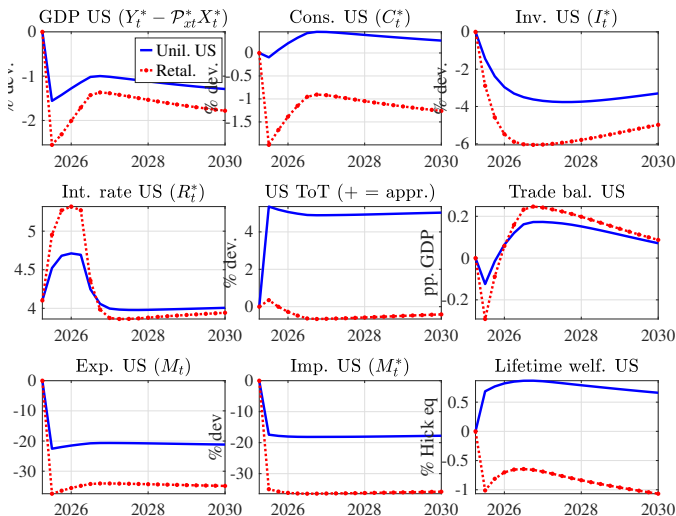
Retaliation - Output

- Fall in US output and trade balance deterioration double
- US Welfare now falls

Figure panels: GDP US ($Y_t^* - \mathcal{P}_{xt}^* X_t^*$); Cons. US ($C_t^*$); Inv. US ($I_t^*$); Int. rate US ($R_t^*$); US ToT ($+$ = appr.); Trade bal. US; Exp. US (M_t); Imp. US (M_t^*); Lifetime welf. US. Legend: Unil. US; Retal.

Retaliation ROW

▶ ROW initially falls more, but converges to lower loss than unilateral
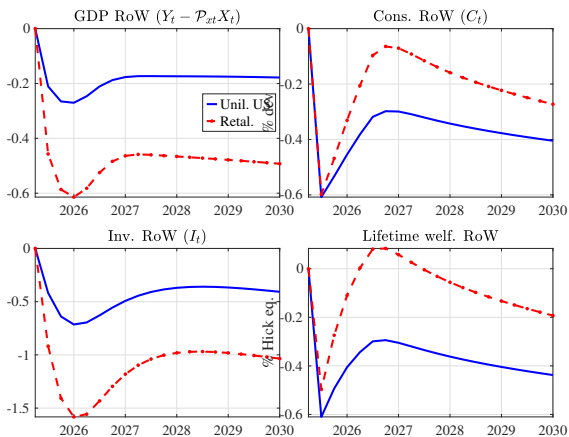
Messages

- Tariff leads to permanently lower GDP

- Trade balance deteriorates on impact

- Impact effects are large relative to steady state, due to price rigidities

- Without retaliation, even with output loss, US gains

- With global retaliation everyone loses, but in our calculation US loses much more, since US is a small relative to the world economy

But global retaliation has not happened

- Reduce the degree of retaliation to mimic China's response
- If only China retaliates, US still gains
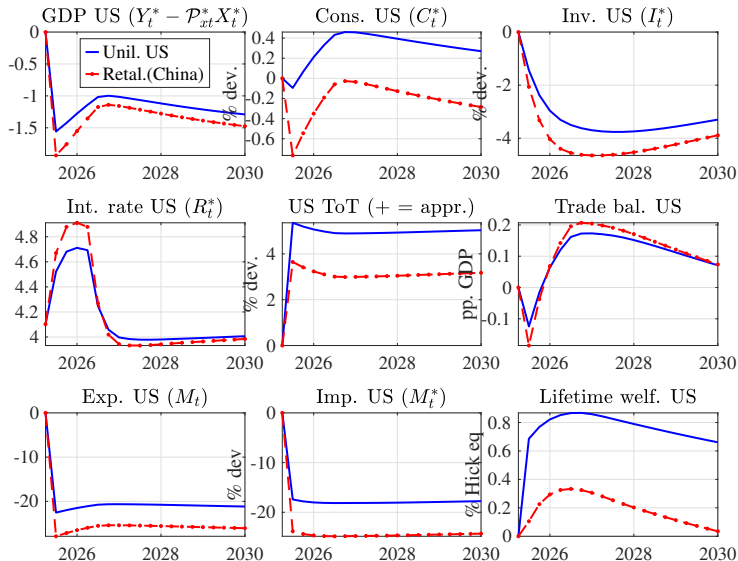
Baseline results change with different specifications

1. Alternative pricing - LCP, DCP
2. Alternative monetary policies - PPI targeting
3. Lower elasticity of substitution λ
4. No intermediate imports
5. Alternative financial market structure - complete markets

Alternative currency of trade pricing

- ▶ With LCP the response of output and trade balance is reversed
- ▶ Exports are unchanged while imports drop sharply
- ▶ Big temporary boom in GDP
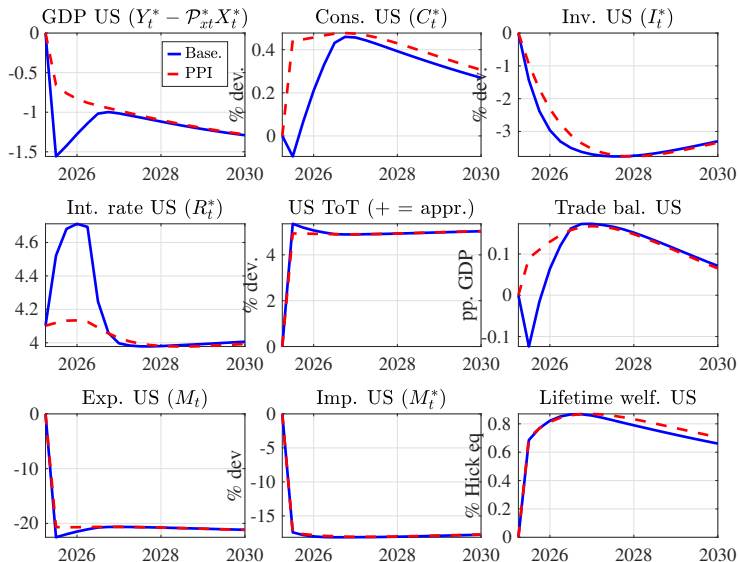- ▶ DCP is close to the baseline - high pass-through to ROW
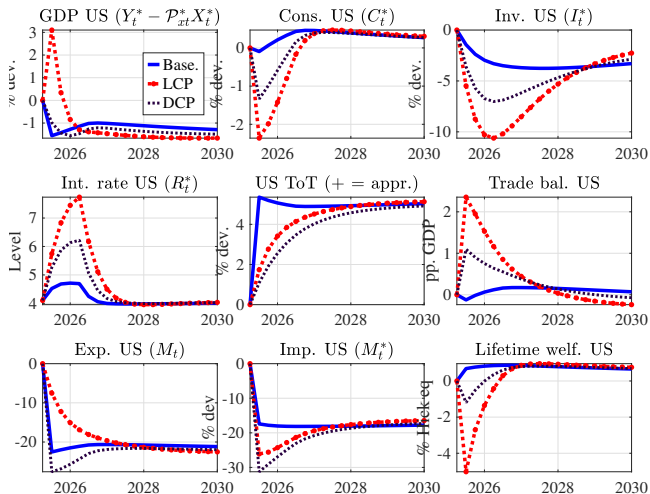
Alternative currency of pricing - Spillovers

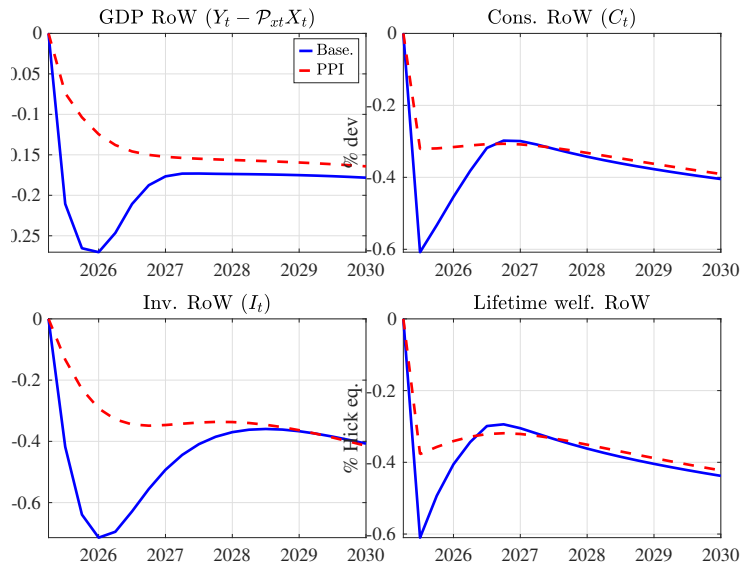- Response of ROW similar to baseline
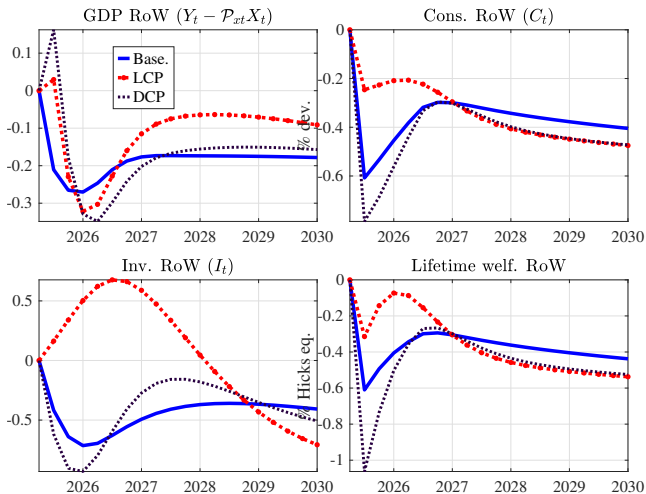
Alternative Monetary policy: PPI targeting

- ▶ Allows for much higher CPI inflation, avoids interest rate spike
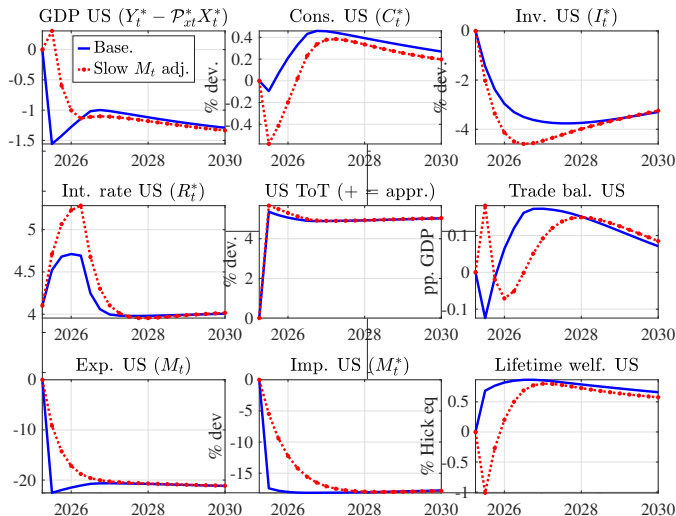- ▶ Close to optimal policy?

GDP US $(Y_t^* - \mathcal{P}_{xt}^* X_t^*)$

Cons. US (C_t^*)

Inv. US (I_t^*)

Int. rate US (R_t^*)

US ToT $(+ = \text{appr.})$

Trade bal. US

Exp. US (M_t)

Imp. US (M_t^*)

Lifetime welf. US

PPI targeting
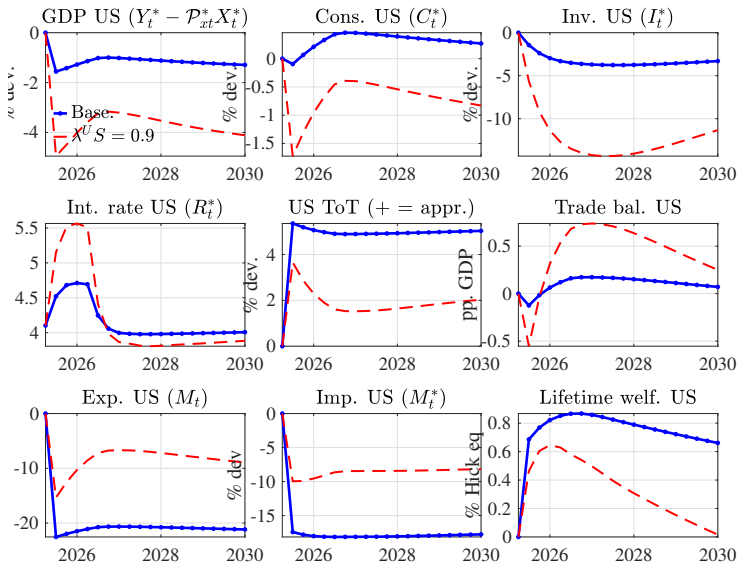
► Spillover effects much less with PPI targeting

Allowing for adjustment costs of trade

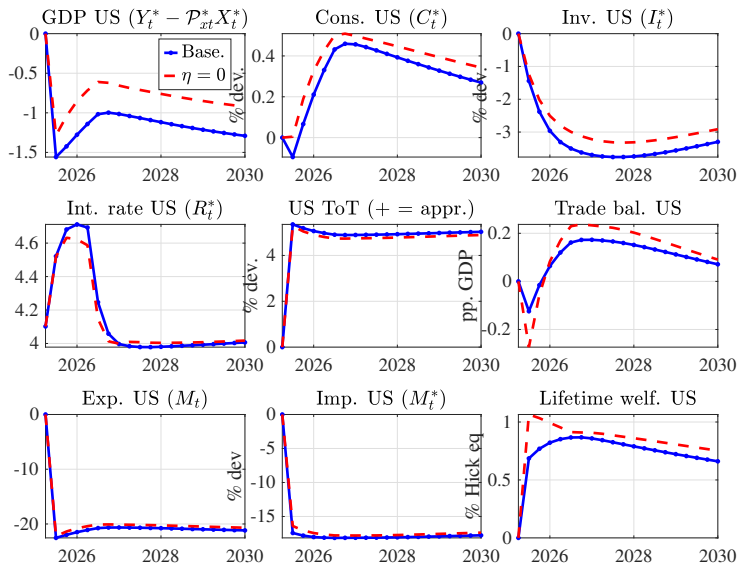▶ Trade balance improves and initial output response is positive

Low domestic elasticity

▶ Lower elasticity (λ) of substitution for US severely reduces the benefits of the unilateral tariff

No intermediate imports

▶ Both own effects and spillovers from a unilateral tariff are reduced absent supply chains

GDP US $(Y_t^* - \mathcal{P}_{xt}^* X_t^*)$, Cons. US (C_t^*), Inv. US (I_t^*), Int. rate US (R_t^*), US ToT (+ = appr.), Trade bal. US, Exp. US (M_t), Imp. US (M_t^*), Lifetime welf. US. Legend: Base., $\eta = 0$.
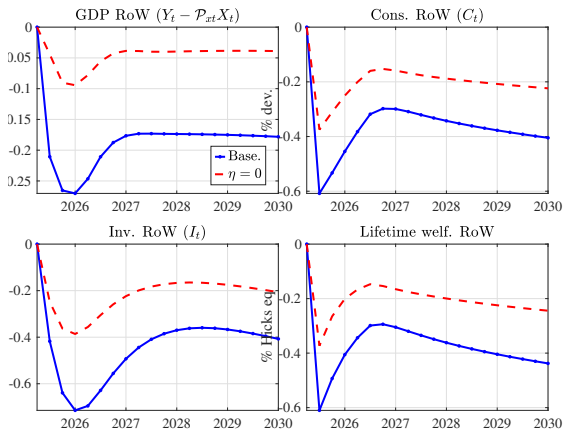
No intermediate imports ROW

▶ Both own effects and spillovers from a unilateral tariff are reduced absent supply chains

Complete Markets

- Financial market structure is a critical determinant of tariff effects
- Income effects of tariffs are eliminated by risk sharing
- Complete markets lead the welfare cost to be shared, and US does worse, even with a unilateral tariff
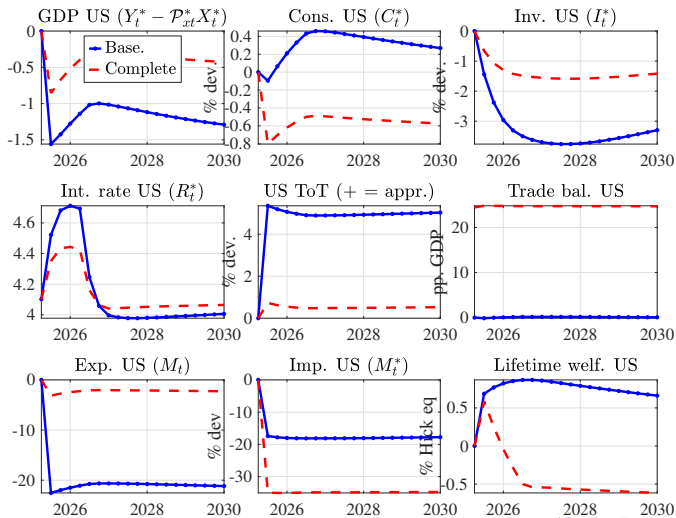
Complete Markets

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- Complete markets lead the welfare cost to be shared, and US does worse, even with a unilateral tariff
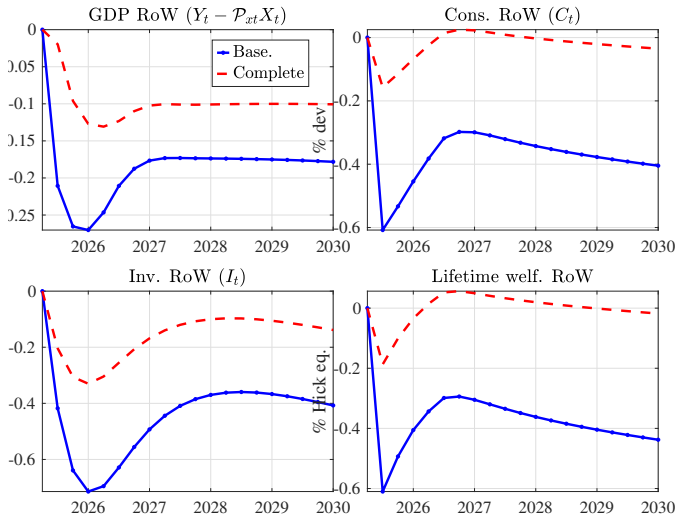
Other extensions in paper

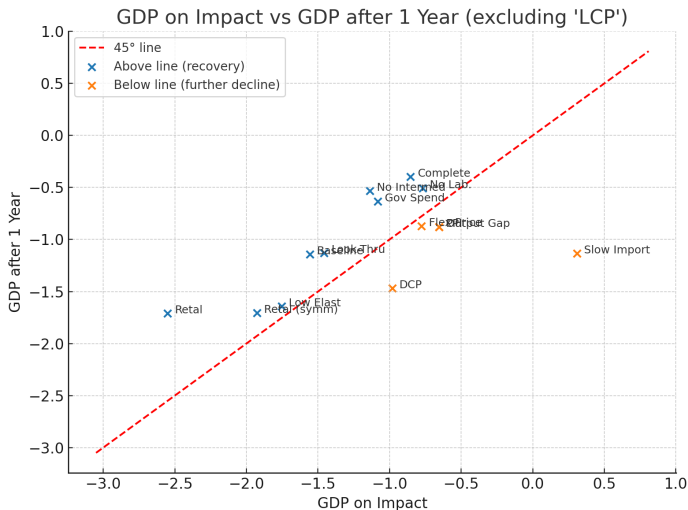1. Anticipation effects
2. Tariff revenue used to fund fiscal spending

Summarizing all the cases: GDP US
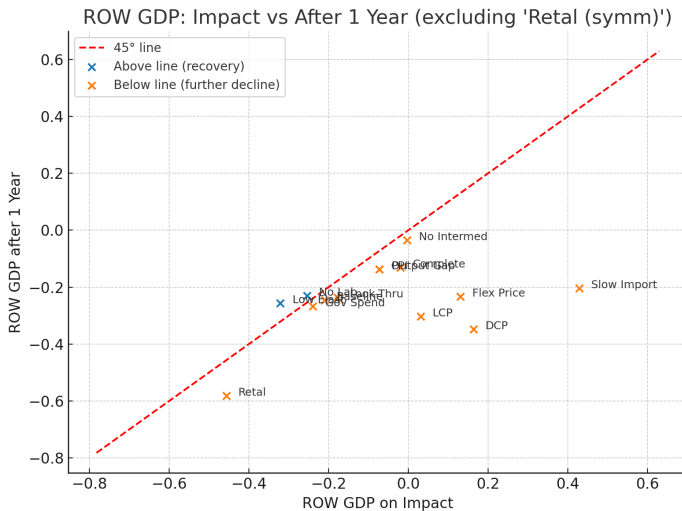
- ▶ Compares impact effect to medium run response
- ▶ In most cases, GDP effect is greater on impact

GDP on Impact vs GDP after 1 Year (excluding 'LCP')
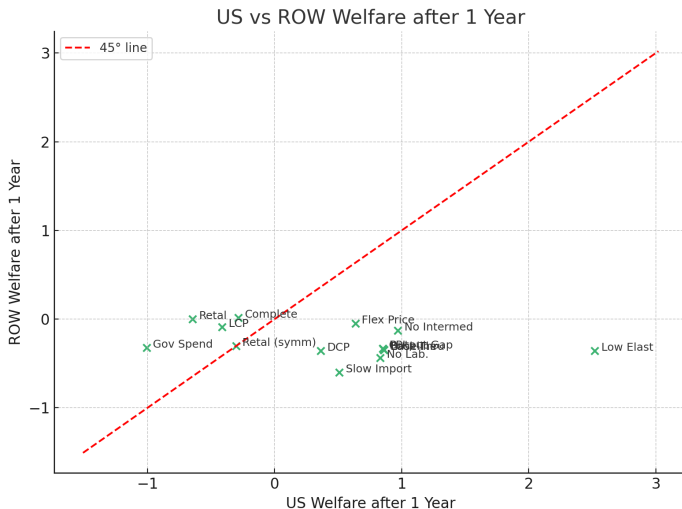
Summary GDP for ROW

- In most cases, GDP for ROW gets worse over time

ROW GDP: Impact vs After 1 Year (excluding 'Retal (symm)')
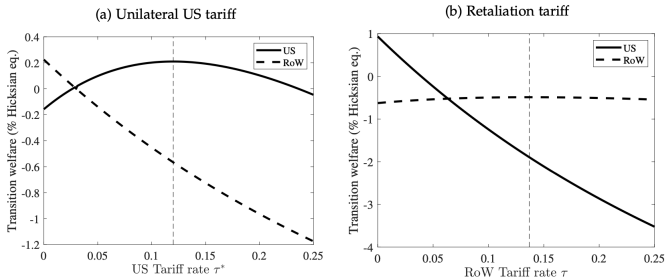
Summary Welfare

▶ US welfare higher through market power

US vs ROW Welfare after 1 Year

What is the optimal tariff?

▶ Quite close to our 13 percent baseline

▶ Significantly lower than the monopoly tariff rate $\frac{1}{\lambda-1}=25$

▶ Domestic distortions and sticky prices raise the welfare cost of tariff

Figure 2: Welfare-maximizing unilateral and retaliation tariffs.

Note: **Unilateral US tariff**: The figure shows US and other countries' welfare computed on the entire transition for different permanent levels of US tariffs τ^*, keeping other countries' tariff at $\tau = 0.03$. The dotted vertical line materializes the welfare-maximizing tariff rate. **Retaliation tariff**: The figure shows US and other countries' welfare computed on the entire transition for different permanent levels of other countries' tariff at τ, keeping the US tariff rate at its welfare-maximizing level $\tau^* = 0.12$. The dotted vertical line materializes the welfare-maximizing tariff rate.

Conclusions

- Effects of a tariff shock is complicated - depends on many structural features

- Analysis captures key dimensions: vertical integration of supply chains, monetary policy responses, international interactions

- Ignores details of sectoral heterogeneity and sectoral input-output linkages

- Four factors are key
    - Asymmetry in size effects of tariff shock
    - Response of monetary policy and types of nominal rigidities
    - Importance of intermediate inputs & trade elasticities
    - Financial market structure

- Different assumptions with respect to these factors will give different quantitative and qualitative effects

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