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A BRIEF MACROECONOMIC ANALYSIS

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ABSTRACT

We quantify the macroeconomic effects of the tariff measures announced (but not entirely implemented yet) on Liberation Day (April 2nd, 2025) through the lens of a New-Keynesian two-country model calibrated to the US and the rest of the world. We study both a unilateral 10pp tariff increase and a global trade war scenario with retalia- tory tariffs of a similar magnitude. In either case, tariffs are always sharply contractionary for US GDP, increasing inflation and widening the trade deficit. Measured in welfare terms a unilateral tariff generates gains for the US due to a large terms of trade appreciation, but these US welfare gains vanish with global retaliation. Three features of the model are critical in the evaluation of the tariff impact - the asymmetry in size and openness between the US and the rest of the world, the endogenous response of monetary policy to the inflationary effects of tariffs, and the importance of trade in intermediate goods for the scale of the global response to a tariff shock.

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1 Introduction

The introduction of wide-ranging tariffs announced on "Liberation Day" is set to have far-reaching consequences for international trade patterns and the US and world economies. These measures, although not yet fully applied, consist of a universal baseline tariff of 10%, alongside higher rates targeting countries with substantial trade surpluses, are expected to profoundly reshape existing trade relationships and economic structures.

Retaliatory measures taken by trading partners can significantly amplify these effects. Reciprocal tariff hikes raise the cost of traded goods globally, reducing welfare and employment. Recent studies suggest that retaliatory tariffs may entirely offset any initial terms-of-trade gains for the US, leading to welfare losses of up to 1% and a decline in global employment of around 0.5% (Ignatenko et al. (2025); Piermartini and Teh (2005)). These findings underscore the risks associated with escalating trade conflicts. In addition, tariffs are likely to exert upward pressure on prices, prompting central banks to tighten monetary policy in response to rising inflation. Higher interest rates depress aggregate demand, further weakening economic activity. Dynamic stochastic general equilibrium (DSGE) models consistently show that such monetary responses exacerbate declines in both investment and exports (Hunt et al. (2020)).

This note quantifies the effects of the measures announced on "Liberation Day" and the associated large-scale increase in US import tariffs applied to virtually all trading partners. We employ a general equilibrium model featuring trade in both final and intermediate goods, sticky prices, and monetary policy. The model is calibrated to represent the US and the rest of the world, and we assess the effects of both unilateral and global increases in tariff rates. Given the difficulty in coming up with a precise number, we consider a (round) 10pp increase in tariffs, starting from a 3% global tariff rate.

Tariffs are taxes on imports. They drive a wedge between pre- and post-tariff prices, reducing demand for imports and depressing prices for exporters in partner countries. At the same time, tariffs increase demand for domestically produced goods, raising their prices. As a result, the terms of trade — defined as the relative price of domestic to foreign goods — improve, potentially benefiting local consumers. Whether this benefit outweighs the cost of tariffs depends on several factors. If tariff revenues are returned to households — either through lump-sum transfers or lower taxes — there may be a net welfare gain from unilateral tariffs. The extent of this gain critically depends on the price elasticity of imports.

While this mechanism applies to trade in final goods, trade in intermediate goods — where firms import inputs for production — operates in a similar fashion. However, the resulting effects now bear directly on production costs rather than consumption. Beyond these demand-side considerations, broader general equilibrium effects must be taken into account. First, retaliation by trade partners may negate the initial terms-of-trade improvement, leaving both sides paying more for traded goods and experiencing a negative income effect.[1] Second, household responses

[1] See Auray, Devereux, and Eyquem (2024) for a macroeconomic set-up allowing for strategic trade policy.

to tariffs, particularly in terms of labor supply, can affect the overall supply of goods, influencing prices and quantities in equilibrium. Finally, tariff-induced inflationary pressures may lead to monetary tightening, lowering aggregate demand and amplifying the contraction in economic activity.[2]

Our model allows a simple yet comprehensive evaluation of the effects of the US tariff shock and possible retaliation, incorporating the channels discussed above. We consider an arbitrary 10 percentage point increase in tariffs. The responses can be briefly summarized. First, the tariff is contractionary, whether imposed unilaterally by the US or by all countries as part of global retaliation. In the baseline case, output falls by 3 percent on impact in the US – 5 percent under retaliation, and converges to a lower steady state GDP by 1 percent. Output also falls in the rest of the world, but to a lesser extent than in the US. Second, while the aim of the 'Liberation Day' tariffs is ostensibly to eliminate the US trade balance, in our model the US trade balance *deteriorates* on impact. This holds true – and is further amplified – when the rest of the world retaliates with equal tariffs to the US. In addition, while a unilateral tariff improves overall welfare for the US, as it generates a strong terms-of-trade improvement, this welfare gain is fully eliminated in the case of tariff retaliation, and global welfare is lower in the long run. In fact, with equal retaliation the US suffers much more in welfare terms.

Three key features of the baseline model are important in the understanding of the response to the tariff shocks. First, the calibrated model implies a substantial asymmetry between the US and the rest of the world. While the US is the largest single economy in the world, it is small as a fraction of global GDP, and evaluated in a bilateral sense, it is more open to trade with the rest of the world than the rest of the world with the US. This implies that an equal-sized tariff in both regions leads to a larger negative output effect on the US than on the rest of the world. Secondly, the response to a permanent tariff is much larger in the short run than in the long run. This is due to an endogenous response of monetary policy to the burst of CPI inflation following the tariff shock. Finally, the presence of global supply chains in the form of imported intermediate goods is critical for the scale effect of the tariff response. Both the impact and long run negative effects of the tariff shock would be substantially smaller in the absence of imported intermediate goods.

Beyond the baseline model, we explore a range of alternative assumptions about trade elasticities, labor supply, use of intermediate goods in production, price flexibility, monetary policy responses, and disbursement of the tariff revenue. While the quantitative responses vary, in all cases we find substantial output and welfare costs of global tariff increases, and in all cases, the long run negative welfare effects are much larger for the US.

This note is structured to allow for a clear identification of these mechanisms: pure demand effects, combined demand and supply effects, unilateral versus global tariff shocks, the role of trade elasticities, and the consequences of monetary policy. The model setup and calibration are presented in Section 2, and the results are discussed in Section 3.

[2]See Bergin and Corsetti (2023), Bianchi and Coulibaly (2025) for discussions regarding the optimal monetary response to tariff shocks, Bandera et al. (2023) for a discussion of how monetary policy should respond to supply shocks.

2 The Model

We describe a model with two countries denoted Home and Foreign, supposed to represent the rest of the world and the US economy, respectively. Households supply labor and consume goods from both countries. The world is populated with a unit mass of agents and Home has share n of these, with Foreign share $1-n$. We assume that firms use a combination of labor and traded intermediate goods to produce, set prices in the currency of producers (PCP) – as a baseline – and adjust prices constrained by Rotemberg price adjustment costs. Households in both countries have preferences over consumption and hours worked. There is international trade in bonds issued in the Foreign country, and Home households face a cost when changing their net foreign asset position.

2.1 Households

The representative Home household maximizes its welfare index:

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

where σ is the degree of relative risk aversion and $1/\psi$ is the Frisch elasticity on labor supply. The internationally traded bond is issued by Foreign residents (the US). Home households also have access to Home one-period and long-term bonds. They face the following nominal budget constraint:

$$\begin{aligned} S_t F_t + B_t + Q_t B_t^L + P_{ht} C_{ht} \quad &+ \quad (1+\tau_t)\, S_t P_{ft}^* C_{ft} + P_t \Lambda_t = S_t F_{t-1} R_{t-1}^* \\ &+ \quad B_{t-1} R_{t-1} + Q_{t-1} B_{t-1}^L R_{t-1}^L + W_t H_t + \Pi_t + TR_t, \end{aligned} \tag{2}$$

Here B_t denotes the amount of Home one-period bonds bought by Home households paying a return R_t between t and $t+1$, while B_t^L is the amount of Home long-term bonds bought at price Q_t and paying a return R_t^L between t and $t+1$, and F_t represents the internationally traded bond, paying a return R_t^* between t and $t+1$. Following Woodford, maturity is introduced by assuming that a fraction $(1-\rho)$ of long-term bonds mature each period and the issuer government pays back the corresponding principal to bondholders. For the remaining fraction of bonds ρ, the issuer pays a coupon r and the principal payment is due in the future. Hence, ρ governs the average maturity of government bonds, which is $1/(1-\rho)$ periods and the return on long-term bonds writes:

$$R_t^L = \frac{1-\rho+\rho(r+Q_{t+1})}{Q_t} \tag{3}$$

Further, trading international bonds incurs the payment of a small adjustment cost $\Lambda_t = \frac{\nu}{2}\left(\frac{S_t F_t}{P_t} - \frac{SF}{P}\right)^2$, proportional to the deviation of real bonds to their steady-state value. The bundle structure of adjustment costs mimics that of final goods.

The representative household in the Home economy consumes Home goods in quantity C_{ht}

at the price P_{ht} and Foreign goods in quantity C_{ft} at the price $(1+\tau_t)\, S_t P^*_{ft}$, where S_t is the exchange rate, P^*_{ft} is the foreign currency price of the foreign good, and τ_t is the tariff rate. The consumption bundle is:

$$C_t = \left(\gamma^{1/\lambda} C_{ht}^{1-1/\lambda} + (1-\gamma)^{1/\lambda}\, C_{ft}^{1-1/\lambda}\right)^{\frac{1}{1-1/\lambda}}, \tag{4}$$

where $\gamma = n + x\,(1-n)$, and x denotes Home bias. The aggregate consumption price index is:

$$P_t = \left(\gamma P_{ht}^{1-\lambda} + (1-\gamma)\left((1+\tau_t)\, S_t P^*_{ft}\right)^{1-\lambda}\right)^{\frac{1}{1-\lambda}}, \tag{5}$$

so that $P_{ht}C_{ht} + (1+\tau_t)\, S_t P^*_{ft} C_{ft} = P_t C_t$. The demand functions of Home and Foreign goods by Home households are respectively:

$$C_{ht} = \gamma \left(\frac{P_{ht}}{P_t}\right)^{-\lambda} C_t = \gamma \mathcal{P}_t^{\lambda} C_t, \tag{6}$$

$$C_{ft} = (1-\gamma)\left(\frac{(1+\tau_t)\, S_t P^*_{ft}}{P_t}\right)^{-\lambda} C_t = (1-\gamma)\left(\frac{\mathcal{P}_t}{(1+\tau_t)\,\mathcal{S}_t}\right)^{\lambda} C_t, \tag{7}$$

where $\mathcal{P}_t = P_t/P_{ht} = \left(\gamma + (1-\gamma)\left((1+\tau_t)\,\mathcal{S}_t\right)^{1-\lambda}\right)^{\frac{1}{1-\lambda}}$ represents the inverse of the relative price of the Home consumption good, while $\mathcal{S}_t = S_t P^*_{ft}/P_{ht}$ stands for Home terms of trade. The first-order conditions of the Home household imply:

$$\beta \mathbb{E}_t \left\{ \frac{u_{ct+1}}{u_{ct}} \frac{S_{t+1} R^*_t}{\pi_{t+1} S_t \left(1 + \nu\,(f_t - f)\right)} \right\} = 1, \tag{8}$$

$$\beta \mathbb{E}_t \left\{ \frac{u_{ct+1}}{u_{ct}} \frac{R_t}{\pi_{t+1}} \right\} = \beta \mathbb{E}_t \left\{ \frac{u_{ct+1}}{u_{ct}} \frac{R^L_t}{\pi_{t+1}} \right\} = 1, \tag{9}$$

$$H_t^{\psi} = \frac{\mathcal{W}_t}{\mathcal{P}_t} u_{ct}, \tag{10}$$

where u_{ct} is the marginal utility of consumption, $\pi_t = P_t/P_{t-1}$ is the gross rates of CPI inflation in the Home country, $\mathcal{W}_t = W_t/P_{ht}$ is the PPI-based real wage and $f_t = S_t F_t / P_t$ denotes Home real holdings of international bonds. The Foreign (US) representative household has a similar utility function, and its consumption bundle and price index are respectively:

$$C^*_t = \left(\gamma^{*1/\lambda} C_{ft}^{*1-1/\lambda} + (1-\gamma^*)^{1/\lambda}\, C_{ht}^{*1-1/\lambda}\right)^{\frac{1}{1-1/\lambda}}, \tag{11}$$

$$P^*_t = \left(\gamma^* P_{ft}^{*1-\lambda} + (1-\gamma^*)\left((1+\tau^*_t)\,\frac{P_{ht}}{S_t}\right)^{1-\lambda}\right)^{\frac{1}{1-\lambda}}, \tag{12}$$

and the corresponding demand functions are:

$$C^*_{ft} = \gamma^* \left(\frac{P_{ft}}{P^*_t}\right)^{-\lambda} = \gamma^* \mathcal{P}^{*\lambda}_t C^*_t, \tag{13}$$

$$C^*_{ht} = (1-\gamma^*)\left(\frac{(1+\tau^*_t)\, P_{ht}}{S_t P^*_t}\right)^{-\lambda} = (1-\gamma^*)\left(\frac{\mathcal{S}_t \mathcal{P}^*_t}{(1+\tau^*_t)}\right)^{\lambda} C^*_t, \tag{14}$$

where $\mathcal{P}^*_t = P^*_t / P^*_{ft} = \left(\gamma^* + (1-\gamma^*)\left((1+\tau^*_t)/\mathcal{S}_t\right)^{1-\lambda}\right)^{\frac{1}{1-\lambda}}$. The Foreign household faces a slightly different nominal budget constraint expressed in the Foreign currency:

$$F^*_t + Q^*_t B^{L*}_t + P^*_{ft} C^*_{ft} + (1+\tau^*_t)\, S^{-1}_t P_{ht} C^*_{ht} = F^*_{t-1} R^*_{t-1} + Q^*_{t-1} B^{L*}_{t-1} R^{L*}_{t-1} + W^*_t H^*_t + \Pi^*_t + TR^*_t, \tag{15}$$

and its first-order conditions imply:

$$\beta \mathbb{E}_t \left\{\frac{u^*_{ct+1}}{u^*_{ct}} \frac{R^*_t}{\pi^*_{t+1}}\right\} = \beta \mathbb{E}_t \left\{\frac{u^*_{ct+1}}{u^*_{ct}} \frac{R^{L*}_t}{\pi^*_{t+1}}\right\} = 1, \tag{16}$$

$$H^{*\psi}_t = \frac{\mathcal{W}^*_t}{\mathcal{P}^*_t} u^*_{ct}, \tag{17}$$

where u^*_{ct} is the marginal utility of consumption, π^*_t and $\mathcal{W}^*_t$ are the Foreign CPI inflation rate and PPI-based real wage.

2.2 Firms

Here we focus on Home firms but Foreign firms are assumed to solve a symmetric problem. A measure n of firms in the Home economy produce differentiated goods. The aggregate Home good is a composite of these differentiated goods, where the elasticity of substitution between individual goods is denoted $\epsilon > 1$. The production function for firm i in the Home country is:

$$Y_t(i) = A_t H_t(i)^{1-\alpha} X_t(i)^{\alpha}, \tag{18}$$

where A_t is an exogenous aggregate productivity term. Here, $X_t(i)$ represents the use of intermediate goods by the Home firm i and $H_t(i)$ the use of labor. Intermediate good inputs are composed of Home and Foreign goods in a different composition than that of the consumption aggregator. Namely,

$$X_t(i) = \left(\gamma_x^{\frac{1}{\lambda}} X_{ht}(i)^{\frac{\lambda-1}{\lambda}} + (1-\gamma_x)^{\frac{1}{\lambda}} X_{ft}(i)^{\frac{\lambda-1}{\lambda}}\right)^{\frac{\lambda}{\lambda-1}}, \tag{19}$$

where $X_{jt}(i)$ is the Home firm's use of inputs from country $j = \{h, f\}$. The profits of Home firm i are then:

$$\Pi_t(i) = ((1+s)P_{ht}(i) - MC_t)\, Y_t(i), \tag{20}$$

where $MC_t = A_t^{-1}(1-\alpha)^{\alpha-1}\alpha^{-\alpha}W_t^{1-\alpha}P_{xt}^{\alpha}$ denotes the firm's nominal marginal cost, and where

$$P_{xt} = \left(\gamma_x P_{ht}^{1-\lambda} + (1-\gamma_x)((1+\tau_t)S_t P_{ft}^*)^{1-\lambda}\right)^{\frac{1}{1-\lambda}}, \tag{21}$$

is the price index relevant for the firm's use of intermediate inputs, s represents a subsidy to offset the monopoly distortion in pricing, and where τ_t is the tariff rate on imports, assumed to be the same as the rate paid by household consumers. Cost minimization by the firm implies:

$$(1-\alpha)\frac{Y_t(i)}{H_t(i)} = \frac{W_t}{MC_t} \text{ and } \alpha\frac{Y_t(i)}{X_t(i)} = \frac{P_{xt}}{MC_t}, \tag{22}$$

with

$$\begin{aligned} X_{ht}(i) &= \gamma_x\left(\frac{P_{ht}}{P_{xt}}\right)^{-\lambda} X_t(i) = \gamma_x \mathcal{P}_{xt}^{\lambda} X_t(i), & (23)\\ X_{ft}(i) &= (1-\gamma_x)\left(\frac{(1+\tau_t)S_t P_{ft}^*}{P_{xt}}\right)^{-\lambda} X_t(i) = (1-\gamma_x)\left(\frac{\mathcal{P}_{xt}}{(1+\tau_t)\mathcal{S}_t}\right)^{\lambda} X_t(i), & (24)\end{aligned}$$

where $\mathcal{P}_{xt}$ is the equivalent of $\mathcal{P}_t$ for intermediate goods.[3] The firm chooses its price to maximize the present value of expected profits, net of price adjustment costs:

$$\mathbb{E}_t\sum_{j=0}^{\infty}\omega_{t+j}\left(\Pi_{t+j}(i) - \frac{\phi}{2}\left(\frac{P_{ht+j}(i)}{P_{ht+j-1}(i)} - 1\right)^2 P_{ht+j}(i)\, Y_{t+j}(i)\right), \tag{25}$$

where we defined $\omega_t = \beta\frac{u_{ct}\mathcal{P}_{t-1}}{u_{ct-1}\mathcal{P}_t}$ as the firm's nominal stochastic discount factor. Parameter ϕ captures the presence of a price adjustment cost for the firm. Price adjustment costs are proportional to the nominal value of Home output, to be consistent with the nominal profit objective function of the firm. The first-order condition for profit maximization for the Home firm i takes into account the individual demand of good i, *i.e* $Y_t^d(i) = (P_{ht}(i)/P_{ht})^{-\epsilon} Y_t$ and is the same for all producers so that $P_{ht}(i) = P_{ht}$ and $Y_t(i) = Y_t$ and that the i index can be dropped. It implies:

$$\theta + \phi\epsilon^{-1}\left(\pi_{ht}(\pi_{ht}-1) - \mathbb{E}_t\left\{\omega_{t+1}\pi_{ht+1}(\pi_{ht+1}-1)\frac{Y_{t+1}}{Y_t}\right\}\right) = \mathcal{MC}_t, \tag{26}$$

where $\theta = \frac{(1+s)(\epsilon-1)}{\epsilon}$, and:

$$\mathcal{MC}_t = MC_t/P_{ht} = \mathcal{MC}_t = \frac{\mathcal{W}_t^{1-\alpha}\mathcal{P}_{xt}^{\alpha}}{A_t\alpha^{\alpha}(1-\alpha)^{1-\alpha}}. \tag{27}$$

Using symmetry among producers, the factor demands can be rewritten as:

$$(1-\alpha)\mathcal{MC}_t Y_t = \mathcal{W}_t H_t, \text{ and } \alpha\mathcal{MC}_t Y_t = \mathcal{P}_{xt}X_t, \tag{28}$$

[3] $\mathcal{P}_t$ and $\mathcal{P}_{xt}$ only differ by the presence of potentially different degrees of home bias, respectively in the use of final or intermediate goods.

where $\mathcal{P}_{xt} = P_{xt}/P_{ht}$.

2.3 Economic Policy

There are three separate policy levers in the model.

Fiscal policy may be used to subsidize monopoly firms but we rule out this case and focus on second-best equilibria. [4]

Monetary policy may be used, but we assume simple Taylor-type rules:

$$\log(R_t\beta) = \rho_r \log(R_{t-1}\beta) + (1-\rho_r)\mu \log(\tilde{\pi}_t), \quad (29)$$

$$\log(R_t^*\beta) = \rho_r \log(R_{t-1}^*\beta) + (1-\rho_r)\mu \log(\tilde{\pi}_t^*), \quad (30)$$

where $\tilde{\pi}_t = \pi_t\pi_{t-1}\pi_{t-2}\pi_{t-3}$ is the annual CPI inflation rate of the Home economy, and $\tilde{\pi}_t^*$ is defined similarly.

Finally, trade policy can be used to levy tariffs on imports. Assuming zero government net supply in bonds, the government budget constraints are:

$$TR_t = \tau_t S_t P_{ft}^* \left(C_{ft} + \Lambda_{ft} + X_{ft}\right) - sP_{ht}Y_t, \quad (31)$$

$$TR_t^* = \tau_t^* S_t^{-1} P_{ht} \left(C_{ht}^* + X_{ht}^*\right) - sP_{ft}^*Y_t^*. \quad (32)$$

2.4 Equilibrium and Baseline Parameter Values

Appendix A details the definition of a competitive equilibrium and the associated equations. The model is parameterized to a quarterly frequency. The Home country represents the rest of the world while the Foreign economy represents the US.

Households preferences. The discount factor of households is $\beta = 0.99$, consistent with an annual real interest rate of 4%. The relative size of the Foreign country (the US) is calibrated using the relative population of the US, $1 - n = 0.083$ as in Auray, Devereux, and Eyquem (2024). Regarding preferences, we consider a baseline value of $\sigma = 1.5$, and a Frisch elasticity of $\psi^{-1} = 2.5$ following Chetty et al. (2011).

Trade and Financial markets Further, we assume a home bias parameter $x = 0.72$ to match a trade openness of 0.25 in the US with a baseline (pre-shock) level of tariffs of $\tau = \tau^* = 0.05$. This leads to $\gamma = \gamma_x = 0.7432$, while in the rest of the world import weights are $\gamma^* = \gamma_x^* = 0.9768$, and illustrates the fact that the US, even though they are relatively less open than many economies,

[4] We see this as the most reasonable assumption. First, we note that a large empirical literature has persuasively established the fact of markups in almost all countries. See De Loecker, Eeckhout, and Unger (2020) for an empirical characterization of markups in the US, and De Loecker and Eeckhout (2018) for a global perspective. Second political constraints may make it impossible for the fiscal authority to subsidize monopolistic firms. Finally, informational asymmetries between firms and the government (not modeled here) prevent the use of targeted subsidies for firms with market power.

are more reliant on imports from the rest of the world than the other way round – think for instance, about how much imports from the US represent as a percentage of GDP in the rest of the world. The trade elasticity is $\lambda = 5$, which is on the high end of the range estimated by Feenstra et al. (2018), but is more appropriate for the evaluation of trade policy. It is also consistent with the average empirical estimates proposed by Imbs and Mejean (2017). Finally, the bond adjustment cost parameter suggested by Ghironi and Melitz (2005) is $\nu = 0.0025$.

Firms. The elasticity of substitution between varieties is $\epsilon = 6$, consistent with a 20% steady-state price-cost markup. The Rotemberg parameter is $\phi = 100$, which, along with the value of and the baseline value of $\epsilon = 6$ produces a 0.05 slope of the (linearized) new Keynesian Phillips Curves. Following Bergin and Corsetti (2023) and close to Itskhoki and Mukhin (2021), we consider the share of intermediate goods in production to be $\alpha = 0.4$. Finally, we draw on Auray, Devereux, and Eyquem (2024) and assume that the relative TFP of the US is $A^*/A = 1.987$.

Monetary policy and long-term bonds. 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. Regarding long-term bonds, we consider a 10-year maturity $1/(1-\rho) = 40$ implying $\rho = 0.975$, and an annual 1% coupon payment so that $r_c = 0.0025$.

3 Results

We now analyze the effects of a large increase in tariffs. According to the Peterson Institute for International Economics, the average tariff on US imports rose 7pp since early April 2025 from 3% before 'Liberation day'.[5] However, since the US administration seems determined to impose a minimum 10% tariff on all imports, 7pp seems like a rather lower bound and we consider a 10pp increase in tariffs, from 3% to 13%.From our starting value of $\tau_0 = \tau_0^* = 0.03$, which is supposed to represent the situation before 'Liberation Day', we consider two scenarios: (*i*) one where the US unilaterally increase tariffs to $\tau = 0.13$ and (*ii*) one where the rest of the world retaliates and tariffs increase everywhere to $\tau = \tau^* = 0.13$. In all cases, the rise is abrupt, unexpected and treated as permanent. To compute the response to these large MIT shocks, we perform non-linear perfect foresight transition from one steady-state to the new.

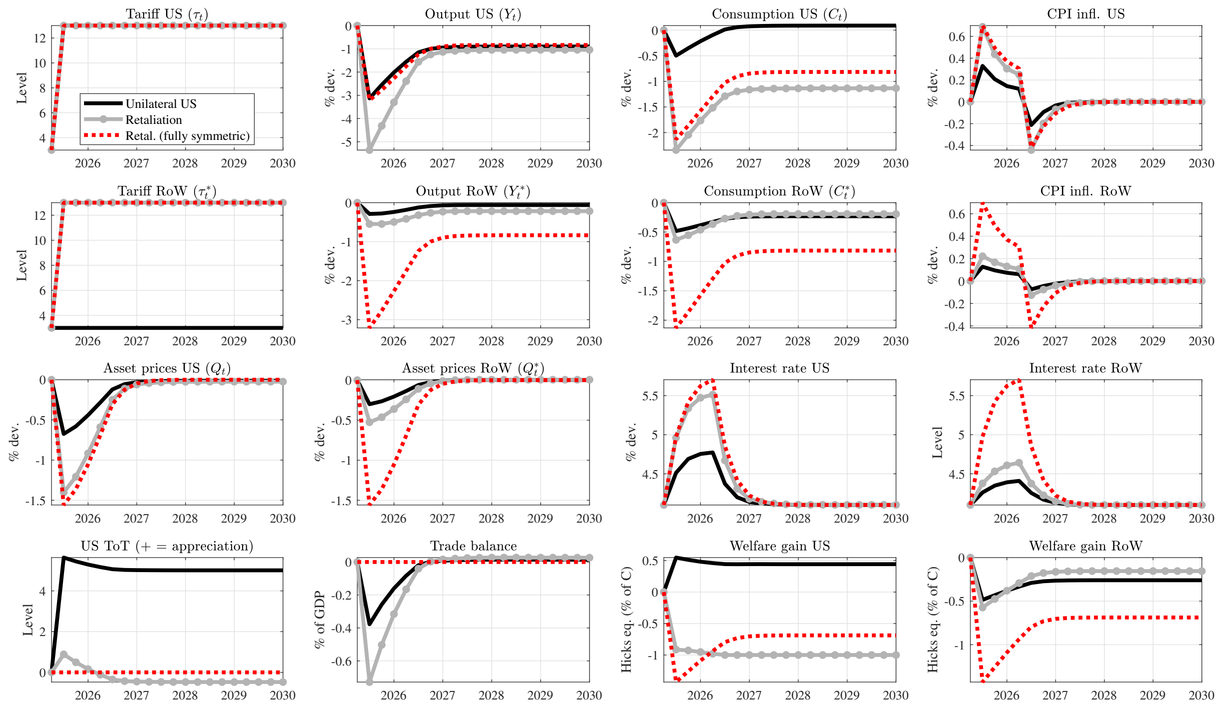
3.1 Baseline case

In the baseline case, prices are sticky and exporters set prices in their own currency (PCP). Figure 1 reports the responses of key variables to the tariff shock.

Figure 1 presents several striking results. Focusing first on the unilateral case, the tariff shock reduces US output by nearly 3% on impact, consumption by 0.5%, and asset prices by 0.7%. At the same time, it raises the CPI inflation rate by 0.3%, prompting the central bank to increase its policy rate by more than 60 basis points. The tariff shock leads to an appreciation of US goods

[5] See https://www.piie.com/research/piie-charts/2019/us-china-trade-war-tariffs-date-chart.

Figure 1: Response to an exogenous tariff shock.



by around 5%, while simultaneously reducing the availability of imported intermediate goods – a key driver of the decline in US output. The impact on consumption is far more moderate, as the improvement in the terms of trade raises household purchasing power. Consistent with this, US households reduce their labor supply – employment falls – in response to the terms-of-trade appreciation, which has positive welfare implications. A key result is that the US trade balance deteriorates significantly on impact, by 0.4 percentage points of GDP. This is due to the large fall in output relative to the muted effect on consumption.

It is apparent from Figure 1 that the impact effect of the tariff shocks is greater than the steady state effect. In steady state, US output falls by almost 1% after unilateral shock, stemming from a combination of a permanently higher relative price of intermediate imports, and a lower long run labor supply. The greater impact effect on output illustrates the importance of the monetary policy response to the tariff shock. The burst of CPI inflation leads to a sharp rise in the US real interest rate which compounds the contractionary impact of the tariff given the degree of price stickiness implied by the Rotemberg specification.

By construction, households in the rest of the world (Home) experience the opposite movement in their terms of trade, which lowers their real income and induces an increase in labor supply. Output in the rest of the world declines only slightly. Their exposure to trade with the US is much smaller than that of US households to trade with the rest of the world, as discussed in the calibration section. As a result, even a large increase in US tariffs has a relatively limited direct impact on them – reflecting, for example, their ability to trade among themselves rather than exclusively with the US. The initial drop in output is just 0.3%, before returning to its pre-shock value. Consumption, however, is more negatively affected, declining by 0.5% on impact and by 0.2% in the long run. The shock also pushes the CPI inflation rate up in the rest of the world, albeit to a lesser extent than in the US – recall that US goods, whose relative price rises in equilibrium, represent only a small share of the CPI in the rest of the world. As a result, the monetary policy tightening abroad is much milder, with policy rates rising by around 30 basis points, and asset prices falling by just 0.3%, less than in the US.

Although US output and consumption fall, in welfare terms, US households experience a gain of approximately 0.5% in consumption equivalent terms on impact (0.4% in the long run), primarily driven by the reduction in their labor supply. In contrast, households in the rest of the world face an equivalent welfare loss on impact – around 0.5% of consumption equivalent – although this loss gradually converges to its long-run value of 0.26% after a few quarters. The main driver of this welfare overshooting is the slow adjustment of prices and the response of monetary policy.

While these results are instructive, the unilateral case is not the most plausible scenario. As shown in Auray, Devereux, and Eyquem (2024), once a country adopts non-cooperative trade policies, the prospect of substantial welfare losses for passive trade partners provides strong incentives for retaliation. Accordingly, it is likely that tariffs will rise globally in the aftermath of 'Liberation Day'.

In this retaliatory scenario, the negative effect on US output is much larger. It's output falls by 5 percent, before converging to a larger steady state decline. In addition, there is a much more pronounced contraction of US consumption. Inflationary pressures are amplified – more than doubled – prompting the US central bank to increase its policy rate by over 140 basis points, while policy rates abroad rise by a more moderate 60 basis points at their peak. Although the US tariff is fully matched by that in the rest of the world, the terms of trade still moves in favour of the US, although significantly less than under the unilateral case. This is due to the asymmetry in openness between the US and all other countries. A given tariff has a greater impact on the terms of trade, the more open is a country.

Despite the greater fall in US consumption, the US trade balance deteriorates even more – almost twice the response under the unilateral case, around 0.72 percentage points of GDP. Again this is due to the smaller terms of trade appreciation with tariff retaliation, which causes the ratio of expenditure to GDP to fall by less in this case.

Under retaliation, US households now experience a large welfare *loss* of 0.9% on impact, which gradually turns into a 1% welfare loss in the long run. In comparison, households in the rest of the world experience a 0.6% welfare loss on impact, which turns into a smaller 0.15% loss in the long run. Why does the symmetric tariff increase affect the US economy so much more severely than the rest of the world? First, the critical difference lies in the tariffs imposed by the rest of the world, which apply to US exported goods. Second, because the US is substantially more reliant on trade with the rest of the world than the reverse, it is disproportionately affected. This underscores the importance of a coordinated response of the rest of the world to US tariffs.

While the US is the largest single economy in the world and is the largest export market for many countries, it is still a small share of the world economy and world trade. Given that 'Liberation day' launched tariffs against all US trading partners, it is legitimate to imagine a coordinated response from all other countries. In this case, the US becomes a smaller and more open economy than the rest of the world, and in the end suffers more from an equal-sized trade war following the retaliatory tariffs.

We now turn to specific cases designed to highlight the contribution of our key modeling assumptions to the baseline results, starting with the outcome resulting from alternative labor supply dynamics.

3.2 Alternative Supply Dynamics

Our first analysis of alternative cases starts by considering different supply dynamics. We look at two alternative cases; (a) assuming that no intermediate goods in production ($\alpha = 0$), and (b) assuming that labor supply is fully inelastic. Figure 2 presents the responses to the tariff shock, focusing on the symmetric scenario with retaliation, comparing the dynamics in the baseline case with those without intermediate goods in production and with inelastic labor supply.

In the first variant, without intermediate goods in production (dashed black line), US output declines much less than in the baseline, both on impact (-2.5% agains -5.5% in the baseline) and in the long run (-0.4% against -1% in the baseline). Similarly, the output decline in the rest of the world is less than half that of the baseline, both on impact and in the steady state convergence. Without intermediate goods, any change in output is achieved through less labor. Another key difference is in the response of the trade balance. In the absence of imported intermediate goods, the decline in the US trade balance is much smaller - less than half of that in the baseline case.

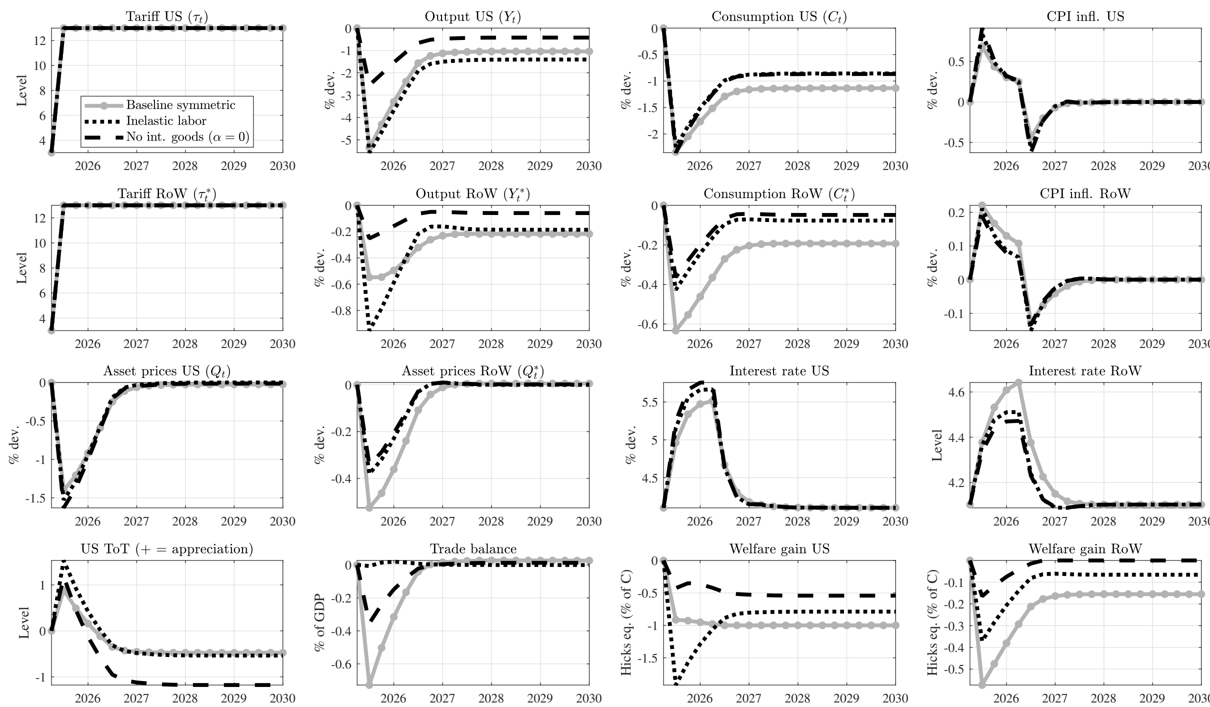
For the US, the drop in output implies declining hours worked that partly compensate the welfare losses from the fall in consumption – from the utility function, lower labor implies higher welfare – which generates an overall smaller welfare loss. Similarly in the rest of the world, the welfare losses from the trade war are dampened. These results highlight the key role of global value chains in amplifying the effects of tariff hikes, and in shaping their welfare implications both qualitatively and quantitatively.

In the second case, tariffs do not generate any additional 'supply' effects from changes in the use of labor.[6] With inelastic labor supply, output varies *only* because households and firms reallocate their spending between US and RoW goods, and because households' incomes are affected. In the second case, the production side is not affected by tariffs through traded intermediate goods.

In Figure 2, any difference in output dynamics between the baseline (circled grey line) and the case of inelastic labor supply (dotted black line) is entirely driven by labor supply. When

[6]Since a substantial share of international trade involves intermediate goods, tariffs still affect the supply side of the economy, but not through changes in labor supply.

Figure 2: Exogenous symmetric tariff shock — Alternative supply dynamics.



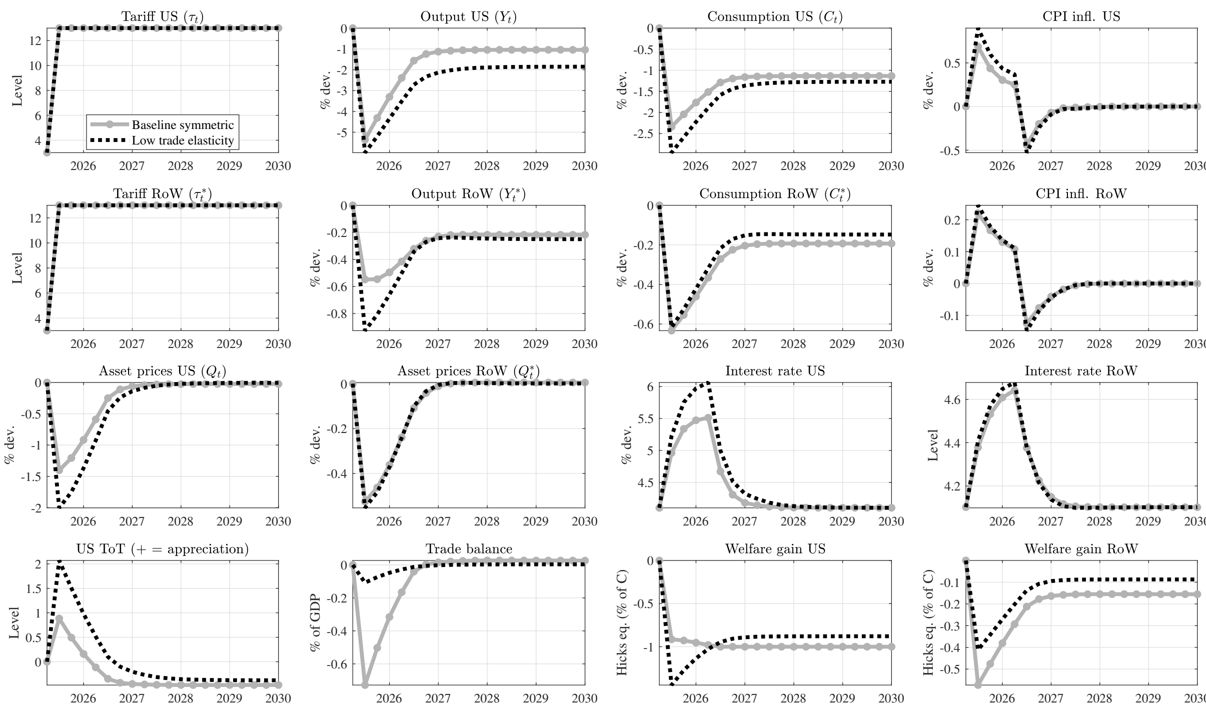
labor supply is fixed, the effects of the symmetric tariff shock are relatively similar in the US economy, but magnifies the impact welfare loss. In the rest of the world inelastic labor supply slightly amplifies the impact fall in output, which leads to a muted response of the trade balance.

3.3 Lower Trade Elasticity

We set $\lambda = 5$ as our baseline value for the trade elasticity. However, the literature in international macroeconomics often employs lower values, typically in the range of 1 to 2, to better capture the cyclical behaviour and volatility of the trade balance. Moreover, many empirical estimates are based on product categories that may be too narrowly defined, potentially overstating the degree of substitutability across goods. This parameter is of critical importance because, in general equilibrium, the trade elasticity governs the extent of tariff pass-through — with lower elasticities leading to greater pass-through. Figure 3 reports the effects of a symmetric tariff shock with a lower trade elasticity of $\lambda = 1.5$ and compares them to the baseline case.

As one might expect, a lower trade elasticity increases the pass-through of the tariff shock and amplifies its effects, particularly for the US. The negative output and consumption responses are somewhat larger, while the increase in inflation reaches 0.9 percentage point – compared to 0.7 percentage points in the baseline scenario. In turn, the monetary policy response is significantly stronger, requiring a 200 basis point increase in the policy rate. The corresponding fall in asset prices is also more pronounced (2% versus 1.5% in the baseline). In the rest of the world, output dynamics is more negative on impact as well, but the trajectory of consumption is slightly im-

Figure 3: Exogenous symmetric tariff shock — lower trade elasticity ($\lambda = 5$ vs. $\lambda = 1.5$)



proved. Since trade flows are less sensitive to changes in tariffs, the response of the trade balance is less negative.

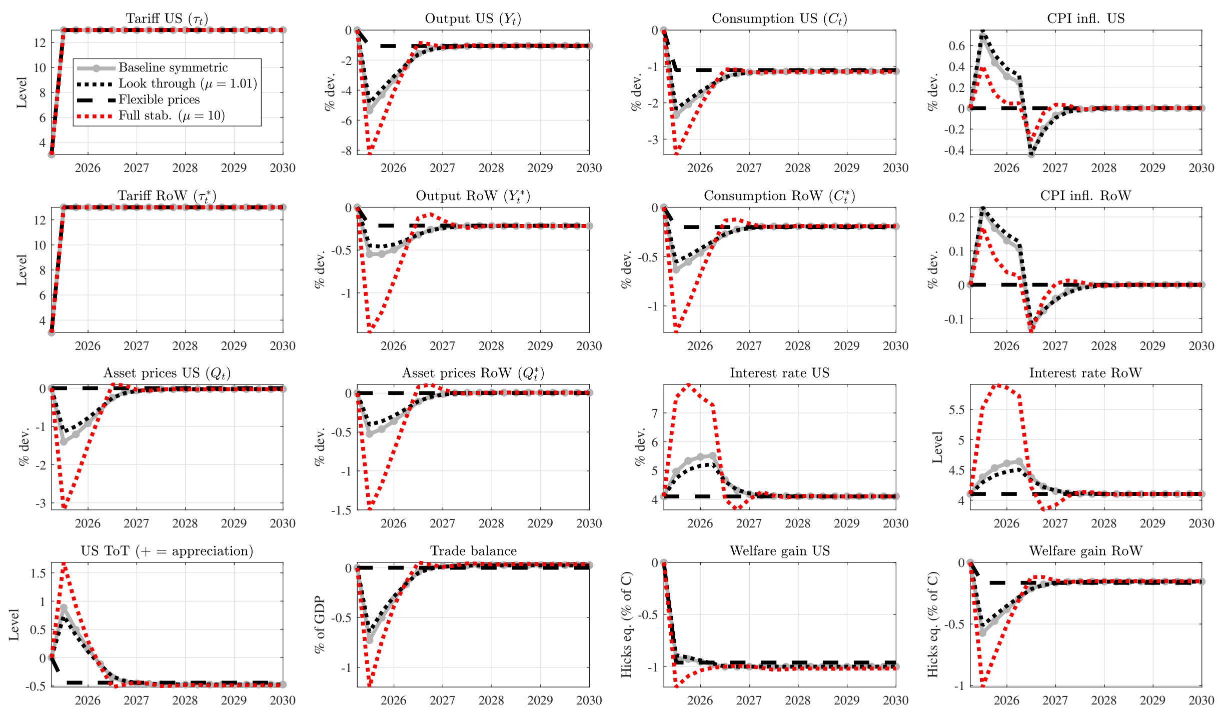
In terms of welfare, the larger decline in US output is accompanied by a less important increase in labor supply, which more than offsets the sharper fall in consumption in the long run. As a result, long-run welfare gains for US households are larger than in the baseline scenario. In the rest of the world, welfare losses are also slightly attenuated, both on impact and in the long run.

3.4 Alternative Monetary Policies and Flexible Prices

We now turn to the role of monetary policy and price stickiness in either amplifying or mitigating the effects of tariffs. In the baseline scenario, central banks are assumed to follow a standard Taylor rule, whereby a substantial increase in CPI inflation calls for a tightening of monetary policy, with adverse consequences for aggregate demand. However, there has been extensive discussions about whether monetary policy should respond or not to supply shocks. Bandera et al. (2023) suggest that the optimal monetary policy response to a supply (tariff) shock may be to 'look through' the inflationary effects, *i.e.*, to refrain from adjusting the policy stance. We consider such a scenario by setting the Taylor-rule coefficient on CPI inflation μ close to unity, a configuration we refer to as 'look-through'. In addition, we analyze a case in which the monetary response fully stabilizes CPI inflation – up to the tariff component which can not be stabilized – and a situation in which prices are fully flexible. The results are presented in

Figure 4.

Figure 4: Exogenous symmetric tariff shock — Alternative monetary policies and flexible prices



Under a look-through policy, the short-run declines in output and consumption in the US are somewhat smaller, but the CPI inflation rate overshoots its baseline trajectory – although not by much. Naturally, the long-run effects are unaffected by this alternative monetary policy response, and the overall path of welfare losses remains essentially unchanged. The tariff shock is also slightly less disruptive in the rest of the world under a look-through policy, but once again, short-run welfare gains and losses remain mostly unchanged.

With flexible prices, the short-run dynamics are dramatically different. In the US, output and consumption decline much more gradually before converging to their negative long-run value. While the long run dynamics are unaffected, the negative impact effects of the tariff shocks are are much larger when firms cannot adjust prices instantaneously. This demonstrates one of the major contributions of our analysis - emphasizing the importance of sticky prices and the monetary policy response to the tariff shock in shaping the short run responses to the tariff shock and the global retaliation.

Under full CPI stabilization, the decline in US output is clearly amplified, and the nominal interest rate skyrockets to more than 8% (against 4% in the steady state). Most short-run effects are magnified by the strong response of central banks – asset prices drop by 3% in the US, and by 1.5% in the rest of the world. CPI inflation rates increase because of the tariff component but no more than under flexible prices (red dotted line). Again, the long-run effects are unaffected by this alternative monetary policy response, but impact welfare losses are much larger in the rest of the world.

3.5 Using Revenues from Tariffs to Buy Local Goods

One last interesting experiment is the way tariff revenues are being used. In the baseline case, we assume they are simply rebated to households lump-sum.[7] But the Trump administration claims they will use them to lower income taxes and stabilize the US deficit. In our Ricardian framework, it does not make a lot of sense to consider this alternative, but we can consider the alternative in which tariff revenues are used to buy local public goods. Assuming full home bias in government spending, Figure 5 compares this case to the baseline.

Figure 5: Exogenous symmetric tariff shock — Using tariff revenues to buy local goods

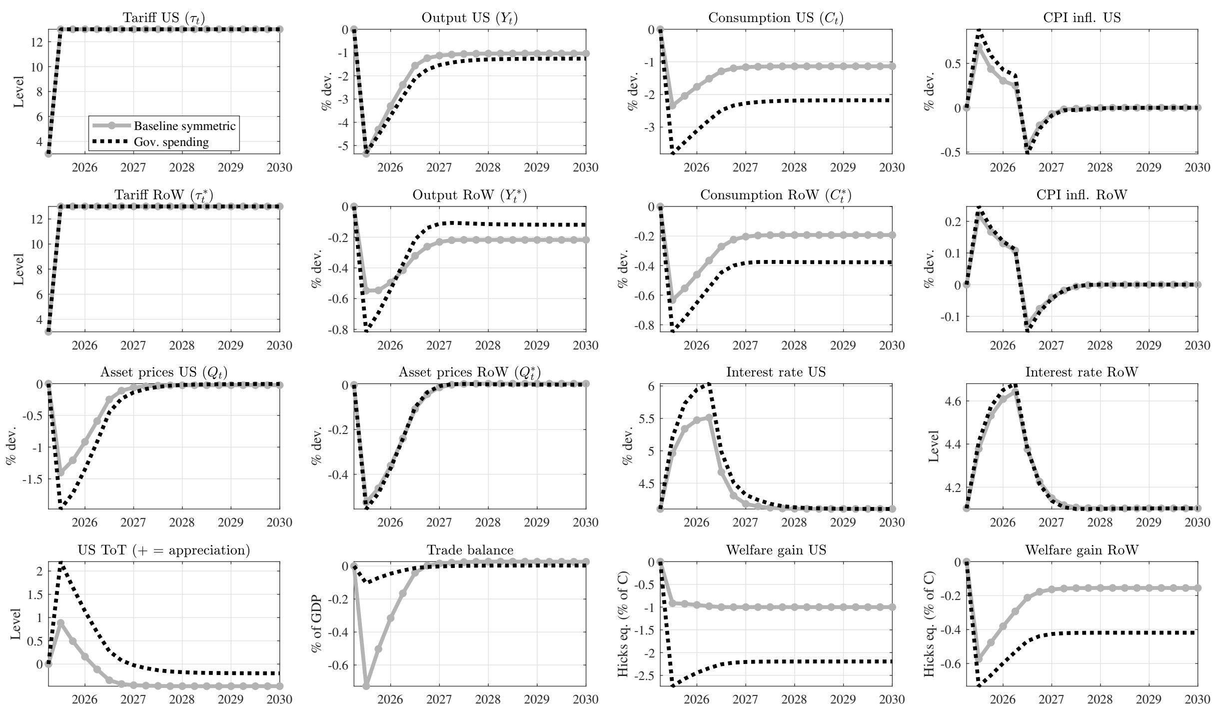


Figure 5 displays a very interesting result: if the government uses tariff revenues to buy local goods instead of rebating the proceeds to households, the terms of trade effect of the joint tariff hike will be magnified. Focusing on the US, as the demand for local goods is further increased by the government purchase, the relative price of US goods increases much more than in the baseline case. Further, since households are now poorer – because they do not get the lump-sum rebate – their consumption falls by more. However the additional demand for US good limits the drop in US output on impact. Consumption in the rest of the world is also more depressed – because households do not receive the proceeds from tariffs there too. Note that the inflationary effects of the tariff hike are substantially amplified globally because of the higher demand for both goods

[7]Since households are Ricardian in our model, the lump-sum rebate is equivalent to a reduction in public debt.

from governments, and so are the monetary policy responses and asset price implications. Last, the welfare effects are much more dramatic than in the baseline case: US households experience a 2.7 welfare losses on impact (2.2% in the long run) and households in the rest of the world a 0.7% welfare loss on impact (0.4% in the long run), mostly because households are much poorer when not receiving the tariff revenues directly.

3.6 Conclusion

This short paper has offered some perspective on the impacts of large tariff shocks in a global economy where countries have different exposure to international trade, where the monetary policy stance is an important feature of the adjustment, and where global supply chains act as important channels of shock transmission. A much more detailed analysis could be done allowing for a multi-sector, multi-country model, allowing for a detailed calibration of sectoral and country trade openness, price and wage stickiness, and differential factor intensities. Nevertheless, our preliminary results suggests that tariffs of the size being currently imposed and the suggested retaliation may have significant short run and long run costs on output levels, inflation rates and economic welfare.

References

Auray, Stéphane, Michael B. Devereux, and Aurélien Eyquem. 2024. "Trade Wars, Nominal Rigidities and Monetary Policy." *Review of Economic Studies* Accepted.

Bandera, Nicolò, Lauren Barnes, Matthieu Chavaz, Silvana Tenreyro, and Lukas von dem Berge. 2023. "Monetary Policy in the Face of Supply Shocks: The Role of Expectations." ECB Forum conference paper.

Bergin, Paul R. and Giancarlo Corsetti. 2023. "The Macroeconomic Stabilization of Tariff Shocks: What is the Optimal Monetary Response?" *Journal of International Economics* :103758.

Bianchi, Javier and Louphou Coulibaly. 2025. "The Optimal Monetary Policy Response to Tariffs." NBER Working Paper 33560.

Chetty, Raj, Adam Guren, Day Manoli, and Andrea Weber. 2011. "Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins." *American Economic Review* 101 (3):471–475.

De Loecker, Jan and Jan Eeckhout. 2018. "Global Market Power." NBER Working Paper 24768.

De Loecker, Jan, Jan Eeckhout, and Gabriel Unger. 2020. "The Rise of Market Power and the Macroeconomic Implications." *The Quarterly Journal of Economics* 135 (2):561–644.

Feenstra, Robert C., Philip Luck, Maurice Obstfeld, and Katheryn N. Russ. 2018. "In Search of the Armington Elasticity." *Review of Economics and Statistics* 100.

Ghironi, Fabio and Marc J. Melitz. 2005. "International Trade and Macroeconomic Dynamics with Heterogeneous Firms." *The Quarterly Journal of Economics* 120 (3):865–915.

Hunt, Benjamin L., Susanna Mursula, Rafael A. Portillo, and Marika Santoro. 2020. "Modeling Trade Tensions: Different Mechanisms in General Equilibrium." IMF Working Paper 20/279.

Ignatenko, Anna, Ahmad Lashkaripour, Luca Macedoni, and Ina Simonovska. 2025. "Making America Great Again? The Economic Impacts of Liberation Day Tariffs." Manuscript.

Imbs, Jean and Isabelle Mejean. 2017. "Trade Elasticities." *Review of International Economics* 25 (2):383–402.

Itskhoki, Oleg and Dmitry Mukhin. 2021. "Exchange Rate Disconnect in General Equilibrium." *Journal of Political Economy* 129 (8):2183–2232.

Piermartini, Roberta and Robert Teh. 2005. "Demystifying Modelling Methods for Trade Policy." WTO Discussion Paper 10.

A The Competitive Equilibrium

We assume that governments rebate the proceeds from tariffs – net from the subsidy s – to the household using lump-sum transfers. Given that Rotemberg costs are paid in units of local goods and using the demand functions for intermediate and final goods, the goods market clearing conditions are given by:

$$Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2\right) = D_t + D^*_{xt}, \tag{A.1}$$

$$Y^*_t \left(1 - \frac{\phi}{2} \left(\pi^*_{ft} - 1\right)^2\right) = D^*_t + D_{xt}, \tag{A.2}$$

where

$$D_t = \gamma \mathcal{P}_t^{\lambda} \left(C_t + \Lambda_t\right) + \gamma_x \mathcal{P}_{xt}^{\lambda} X_t, \tag{A.3}$$

$$D_{xt} = \frac{n}{1-n} \left(\frac{\mathcal{S}_t^{-1}}{1+\tau_t}\right)^{\lambda} \left(\left(1-\gamma\right) \mathcal{P}_t^{\lambda} \left(C_t + \Lambda_t\right) + \left(1-\gamma_x\right) \mathcal{P}_{xt}^{\lambda} X_t\right), \tag{A.4}$$

$$D^*_t = \gamma^* \mathcal{P}_t^{*\lambda} C^*_t + \gamma^*_x \mathcal{P}_{xt}^{*\lambda} X^*_t, \tag{A.5}$$

$$D^*_{xt} = \frac{1-n}{n} \left(\frac{\mathcal{S}_t}{1+\tau^*_t}\right)^{\lambda} \left(\left(1-\gamma^*\right) \mathcal{P}_t^{*\lambda} C^*_t + \left(1-\gamma^*_x\right) \mathcal{P}_{xt}^{*\lambda} X^*_t\right). \tag{A.6}$$

The labor-market clearing conditions are:

$$(1-\alpha) \mathcal{MC}_t A_t H_t^{-\alpha} X_t^{\alpha} = \mathcal{P}_t C_t^{\sigma} H_t^{\psi}, \tag{A.7}$$

$$(1-\alpha) \mathcal{MC}^*_t A^*_t H_t^{*-\alpha} X_t^{*\alpha} = \mathcal{P}^*_t C_t^{*\sigma} H_t^{*\psi}. \tag{A.8}$$

Finally, Home bonds are in zero-net supply so that $B_t = 0$ and the clearing condition on the market for international (Foreign) bonds writes:

$$n F_t + \left(1-n\right) F^*_t = 0. \tag{A.9}$$

Defining $f_t = \frac{S_t F_t}{P_t}$ and $f^*_t = \frac{F^*_t}{P^*_t}$ as the real per-capita net foreign asset positions, Equation (A.9) implies:

$$n f_t + \left(1-n\right) \frac{\mathcal{S}_t \mathcal{P}^*_t}{\mathcal{P}_t} f^*_t = 0. \tag{A.10}$$

Further, the combination of Home and Foreign Euler Equations on Foreign bonds gives rise to a modified uncovered interest rate parity condition:

$$\mathbb{E}_t \left\{ \frac{\omega_{t+1}}{\omega^*_{t+1}} \frac{\mathcal{S}_{t+1}}{\mathcal{S}_t \left(1 + \nu \left(f_t - f\right)\right)} \right\} = 1, \tag{A.11}$$

where, remember, ω_t and ω^*_t are the stochastic discount factors. Last, the consolidation of the

Home household budget constraint with other equilibrium and market clearing conditions gives:

$$f_t = \frac{\mathcal{S}_t \mathcal{P}_{t-1}}{\mathcal{S}_{t-1} \mathcal{P}_t \omega_t^*} f_{t-1} + \mathcal{P}_t^{-1} \left(D_{xt}^* - \frac{1-n}{n} \mathcal{S}_t D_{xt} \right). \tag{A.12}$$

Using appropriate substitutions, the above equations can be reduced to a system of two Phillips Curves (Equations (A.13) and (A.14) below), two good market clearing conditions (Equations (A.15) and (A.16) below), two Euler equations (Equations (A.18)-(A.19) below), and Equations (A.17), (A.20) and (A.21) that describe the external equilibrium – the terms of trade (Equation (A.20) below) and two net foreign asset positions (Equation (A.17 and Equation (A.21) below). Conditional on a given set of shocks $\{A_t, A_t^*\}$, tariffs $\{\tau_t, \tau_t^*\}$, and monetary policies $\{R_t, R_t^*\}$, these equations determine $\left\{\pi_{ht}, \pi_{ft}^*, C_t, C_t^*, Y_t, Y_t^*, R_t^L, R_t^{L*}, f_t, f_t^*, \mathcal{S}_t\right\}$.

$$\begin{aligned}
\theta + \phi\epsilon^{-1} \left(\pi_{ht} \left(\pi_{ht} - 1 \right) - \mathbb{E}_t \left\{ \omega_{t+1} \pi_{ht+1} \left(\pi_{ht+1} - 1 \right) \frac{Y_{t+1}}{Y_t} \right\} \right) &= \mathcal{MC}_t, && \text{(A.13)} \\
\theta + \phi\epsilon^{-1} \left(\pi_{ft}^* \left(\pi_{ft}^* - 1 \right) - \mathbb{E}_t \left\{ \omega_{t+1}^* \pi_{ft+1}^* \left(\pi_{ft+1}^* - 1 \right) \frac{Y_{t+1}^*}{Y_t^*} \right\} \right) &= \mathcal{MC}_t^*, && \text{(A.14)} \\
Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1 \right)^2 \right) - D_t - D_{xt}^* &= 0, && \text{(A.15)} \\
Y_t^* \left(1 - \frac{\phi}{2} \left(\pi_{ft}^* - 1 \right)^2 \right) - D_t^* - D_{xt} &= 0, && \text{(A.16)} \\
n f_t + (1-n) \frac{\mathcal{S}_t \mathcal{P}_t^*}{\mathcal{P}_t} f_t^* &= 0, && \text{(A.17)} \\
\mathbb{E}_t \left\{ \frac{R_t \omega_{t+1}}{\pi_{ht+1}} \right\} = \mathbb{E}_t \left\{ \frac{R_t^L \omega_{t+1}}{\pi_{ht+1}} \right\} &= 1, && \text{(A.18)} \\
\mathbb{E}_t \left\{ \frac{R_t^* \omega_{t+1}^*}{\pi_{ft+1}^*} \right\} = \mathbb{E}_t \left\{ \frac{R_t^{L*} \omega_{t+1}^*}{\pi_{ft+1}^*} \right\} &= 1, && \text{(A.19)} \\
\mathbb{E}_t \left\{ \frac{\omega_{t+1}}{\omega_{t+1}^*} \frac{\mathcal{S}_{t+1}}{\mathcal{S}_t \left(1 + \kappa_t + \nu \left(f_t - f \right) \right)} \right\} &= 1, && \text{(A.20)} \\
f_t - \frac{\mathcal{S}_t \mathcal{P}_{t-1}}{\mathcal{S}_{t-1} \mathcal{P}_t \omega_t^*} f_{t-1} - \mathcal{P}_t^{-1} \left(D_{xt}^* - \frac{1-n}{n} \mathcal{S}_t D_{xt} \right) &= 0. && \text{(A.21)}
\end{aligned}$$

where $\mathcal{MC}_t = \frac{\left(\mathcal{P}_t H_t^{\psi} C_t^{\sigma}\right)^{1-\alpha} \mathcal{P}_{xt}^{\alpha}}{A_t \alpha^{\alpha} (1-\alpha)^{1-\alpha}}$ and $\mathcal{MC}_t^* = \frac{\left(\mathcal{P}_t^* H_t^{*\psi} C_t^{*\sigma}\right)^{1-\alpha} \mathcal{P}_{xt}^{*\alpha}}{A_t \alpha^{\alpha} (1-\alpha)^{1-\alpha}}$ with:

$$H_t = \left(\frac{(1-\alpha) \left(\mathcal{P}_t C_t^{\sigma} \right)^{-\alpha} \mathcal{P}_{xt}^{\alpha} Y_t}{A_t \alpha^{\alpha} (1-\alpha)^{1-\alpha}} \right)^{\frac{1}{1+\alpha\psi}}, \; H_t^* = \left(\frac{(1-\alpha) \left(\mathcal{P}_t^* C_t^{*\sigma} \right)^{-\alpha} \mathcal{P}_{xt}^{*\alpha} Y_t^*}{A_t^* \alpha^{\alpha} (1-\alpha)^{1-\alpha}} \right)^{\frac{1}{1+\psi\alpha}}, \tag{A.22}$$

$$X_t = \frac{\alpha \left(\mathcal{P}_t H_t^{\psi} C_t^{\sigma} \right)^{1-\alpha} \mathcal{P}_{xt}^{\alpha-1} Y_t}{A_t \alpha^{\alpha} (1-\alpha)^{1-\alpha}}, \; X_t^* = \frac{\alpha \left(\mathcal{P}_t^* H_t^{*\psi} C_t^{*\sigma} \right)^{1-\alpha} \mathcal{P}_{xt}^{*\alpha-1} Y_t^*}{A_t^* \alpha^{\alpha} (1-\alpha)^{1-\alpha}}. \tag{A.23}$$

B Detailed derivation of NFA dynamics

Start from the budget constraint assuming zero net supply of Home bonds:

$$S_t F_t + P_{ht} C_{ht} + (1+\tau_t) S_t P^*_{ft} C_{ft} + P_t \Lambda_t = S_t F_{t-1} R^*_{t-1} + W_t H_t + \Pi_t + TR_t \tag{B.24}$$

and substitute the expression of profits and adjustment costs:

$$\begin{aligned} S_t F_t + P_{ht} C_{ht} + (1+\tau_t) S_t P^*_{ft} C_{ft} + P_t \Lambda_t &= S_t F_{t-1} R^*_{t-1} + W_t H_t + (1+s) P_{ht} Y_t \\ &- MC_t - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2 Y_t + TR_t. \end{aligned} \tag{B.25}$$

Use the government constraint and consolidate:

$$S_t F_t + P_{ht} C_{ht} + S_t P^*_{ft} C_{ft} + P_t \Lambda_t = S_t F_{t-1} R^*_{t-1} + W_t H_t + P_{ht} Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2\right) + \tau_t S_t P^*_{ft} X_{ft} - MC_t Y_t. \tag{B.26}$$

Next use the marginal cost conditions:

$$MC_t Y_t = W_t H_t + P_{xt} X_t, \tag{B.27}$$

to simplify:

$$S_t F_t + P_{ht} C_{ht} + S_t P^*_{ft} C_{ft} + P_t \Lambda_t = S_t F_{t-1} R^*_{t-1} + P_{ht} Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2\right) + \tau_t S_t P^*_{ft} X_{ft} - P_{xt} X_t. \tag{B.28}$$

Now use expenditure on intermediate goods:

$$P_{xt} X_t = P_{ht} X_{ht} + (1+\tau_t) S_t P^*_{ft} X_{ft}, \tag{B.29}$$

to get:[8]

$$S_t F_t = S_t F_{t-1} R^*_{t-1} + P_{ht} Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2\right) - P_{ht} \left(C_{ht} + X_{ht} + \Lambda_{ht}\right) - S_t P^*_{ft} \left(C_{ft} + X_{ft} + \Lambda_{ft}\right) \tag{B.30}$$

Now use the Home goods market clearing condition:

$$n Y_t \left(1 - \frac{\phi}{2} \left(\pi_{ht} - 1\right)^2\right) = n \left(C_{ht} + X_{ht} + \Lambda_{ht}\right) + (1-n) \left(C^*_{ht} + X^*_{ht}\right), \tag{B.31}$$

to obtain:

$$S_t F_t = S_t F_{t-1} R^*_{t-1} + \left(\frac{1-n}{n}\right) P_{ht} \left(C^*_{ht} + X^*_{ht}\right) - S_t P^*_{ft} \left(C_{ft} + X_{ft} + \Lambda_{ft}\right), \tag{B.32}$$

[8]Note that Λ_t has the same structure as C_t.

The demand functions for the different goods:

$$C_{ft} + \Lambda_{ft} = (1-\gamma)\left(\frac{\mathcal{P}_t}{(1+\tau_t)\,\mathcal{S}_t}\right)^{\lambda}(C_t + \Lambda_t)\,, \tag{B.33}$$

$$X_{ft} = (1-\gamma_x)\left(\frac{\mathcal{P}_{xt}}{(1+\tau_t)\,\mathcal{S}_t}\right)^{\lambda} X_t, \tag{B.34}$$

$$C^*_{ht} = (1-\gamma^*)\left(\frac{\mathcal{S}_t\mathcal{P}^*_t}{(1+\tau^*_t)}\right)^{\lambda} C^*_t, \tag{B.35}$$

$$X^*_{ht} = (1-\gamma^*_x)\left(\frac{\mathcal{S}_t\mathcal{P}^*_{xt}}{(1+\tau^*_t)}\right)^{\lambda} X^*_t, \tag{B.36}$$

can now be used:

$$S_tF_t = S_tF_{t-1}R^*_{t-1} + P_{ht}D^*_{xt} - \frac{1-n}{n}S_tP^*_{ft}D_{xt}, \tag{B.37}$$

where recall,

$$D_{xt} = \frac{n}{1-n}\left(\frac{\mathcal{S}_t^{-1}}{1+\tau_t}\right)^{\lambda}\Big((1-\gamma)\,\mathcal{P}_t^{\lambda}\,(C_t+\Lambda_t) + (1-\gamma_x)\,\mathcal{P}_{xt}^{\lambda}X_t\Big)\,, \tag{B.38}$$

$$D^*_{xt} = \frac{1-n}{n}\left(\frac{\mathcal{S}_t}{1+\tau^*_t}\right)^{\lambda}\Big((1-\gamma^*)\,\mathcal{P}_t^{*\lambda}C^*_t + (1-\gamma^*_x)\,\mathcal{P}_{xt}^{*\lambda}X^*_t\Big)\,. \tag{B.39}$$

Let us now divide both sides by P_t, recall we defined $f_t = S_tF_t/P_t$ and that $\mathcal{P}_t = P_t/P_{ht}$ and $\mathcal{S}_t = S_tP^*_{ft}/P_{ht}$:

$$f_t = \frac{\mathcal{S}_t\mathcal{P}_{t-1}}{\mathcal{S}_{t-1}\mathcal{P}_t\pi^*_{ft}}f_{t-1}R^*_{t-1} + \mathcal{P}_t^{-1}\left(D^*_{xt} - \frac{1-n}{n}\mathcal{S}_tD_{xt}\right). \tag{B.40}$$

Use the Foreign Euler equation on Foreign bonds:

$$f_t = \frac{\mathcal{S}_t\mathcal{P}_{t-1}}{\mathcal{S}_{t-1}\mathcal{P}_t\omega^*_t}f_{t-1} + \mathcal{P}_t^{-1}\left(D^*_{xt} - \frac{1-n}{n}\mathcal{S}_tD_{xt}\right) \tag{B.41}$$