Could Tariffs Provide a Stimulus? Simple Analytics of Tariffs and the Macro Economy

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Abstract

This paper shows the possible stimulus effects of temporary trade policies in a sticky-price environment. Tariff shocks enter the open-economy IS and Phillips curves. Having constrained monetary policy and a flat Phillips curve due to inputs in production amplifies the inflation from tariffs and may stimulate domestic demand. Unilaterally imposing tariffs on imports may both divert consumption toward domestic goods and promote exports through depreciated terms of trade, ultimately stimulating domestic output. These effects apply to both small and large economies. When the input share in production is large enough, a large country's unilateral trade policy may benefit the domestic economy without causing adverse impacts on foreign consumption or output.

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1. Introduction

Can tariffs be used as a policy tool to stimulate consumption or output without harming neighboring economies? Recently, many countries have imposed tariffs or threatened to use them to achieve domestic objectives, including managing recessions and improving trade balances or employment. Policymakers often associate tariffs with a beggar-thy-neighbor nature, as negative spillovers affecting foreign consumption or output may also elicit foreign retaliation. Moreover, the empirical and theoretical literature continues to debate the extent to which tariffs benefit the domestic economy.

This paper examines the above question using a simple open-economy sticky-price framework. The model is kept simple to isolate key transmission mechanisms in a sticky-price environment. Anticipated future changes in temporary tariffs induce inter-temporal trade motives and affect current consumption. Changes in inter-temporal substitution and expected inflation or deflation are distinct from all static trade models of permanent tariffs and dynamic trade models without nominal frictions.

The effect of tariffs on the domestic economy and their spillover nature depends on whether or not monetary policy actively manages inflation and the slope of the Phillips curve. Under perfect risk sharing, tariff shocks enter into both the open-economy IS curve and the Phillips curve, and hence tariff shocks are both supply and demand shocks. On the demand side, tariffs induce expenditure switching and have direct effects on increasing domestic output. Moreover, the nature of temporary tariffs implies that tariffs are anticipated to fade away. In reality, tariffs remain constant for many years, but this deflationary effect persists as long as future tariffs are anticipated to be lower. On the supply side, tariffs increase the expected inflation because they compress the markup under sticky prices and raise marginal cost.

The impact of tariffs on consumption depends on the response of monetary policy and the dominance of either supply side or demand side in determining expected inflation. When monetary policy actively targets producer price inflation, the real interest rate rises and consumption is depressed due to tariffs. Therefore, tariffs can still stimulate output when the expenditure switching from terms of trade improvement is large enough to offset depressed domestic consumption.

The impact of tariffs in the global economy depends on the response of monetary policy to inflation. With a targeting rule on producer-level inflation, higher tariffs in any country reduces the global output. The previous result of reduced consumption still holds, and global output is proportional to the sum of consumption across countries. Therefore, global output falls following the fall in world consumption. When neither of countries has monetary policy actively controlling inflation, tariffs could improve global output. In this case, unilateral tariffs on domestic imports may stimulate foreign output as the demand for foreign imports rises along with the rise in domestic output when the share of intermediate inputs in production is high enough.

Channels through which tariffs affect output and welfare have been analyzed in quantitative open-economy New Keynesian models. This paper contributes to the understanding of temporary trade policy by deriving analytical results of trade policy for the first time. In particular, this paper shows the novel insights that the aggregate effects of temporary trade protections depend on the production structure of the economy, modeled using roundabout production in the paper.

Barattieri et al. (2018) recognize the importance of inflation and the role of constrained monetary policy for tariffs. However, they could not find any cases where temporary tariffs improve consumption even when monetary policy is constrained due to temporary risk premium shocks. However, they missed an important point that the anticipated lower future tariffs matter for the demand side and affect inter-temporal consumption switching. These effects could be strong for temporary trade protections. This important point is recognized in Erceg et al. (2022), which talks about the effects of tariffs policy reversal, the short note by Lorenzoni (2019) in a stylized two-period model, and even undergraduate textbook Schmitt-Grohé et al. (2022). However, they do not connect to supply-side inflationary pressure from tariffs and analyze channels amplifying tariff-induced expected inflation and potentially reversing negative conclusions related to tariffs. Auray et al. (2020a) shows that tariffs may stimulate consumption but still depress output. This paper also complements Auray et al. (2020a) by analyzing the possibility of tariffs improving both domestic consumption and/or output.

Auray et al. (2020a) focuses on using tariffs as a policy tool in response to various shocks. They show that in response to a reduction in the home country's household discount factor β, a tariff war increases home households' welfare (Figure 7 in their paper). Moreover, the IRF in Figure 10 shows the home country's persistent tariffs increase home households' welfare and consumption, though they are begging thy neighbor. From the same group of authors, Auray et al. (2020b) show that tariffs under non-cooperative tariff wars decrease the consumption and welfare even when the monetary policy is constrained. This paper argues that self-oriented home country's tariffs may benefit the foreign county's and/or output. Therefore, non-cooperative tariffs may improve global consumption. The likelihood of monetary policy being constrained in the future is a key determinant of tariff spillovers and hence the outcome of non-cooperative tariff wars.

Eggertsson et al. (2016) don't discuss tariffs directly, but they mention that policies reducing global integrations on trade or capital accounts aimed at improving net foreign asset positions are welfare improving. Erceg et al. (2022) discuss how intra-temporal and intertemporal elasticities govern whether or not output increases in response to tariffs. They also examine the implication of anticipated policy changes. Erceg et al. (2022), like all other recent papers analyzing tariffs in an open economy New Keynesian framework, implements a computational approach to analyzing tariffs. This paper is the first to analyze temporary tariffs in an analytical sticky-price environment, and it provides a transparent framework to compare and reconcile a range of results from simulations.

Caballero et al. (2021) discuss tariffs when the global economy is potentially permanently stuck at the zero lower bound. They conclude tariffs at the ZLB are begging thy neighbor and tariff wars return the global economy to autarky. Tariffs in their framework without endogenous labor supply have no employment and inflationary effects, and tariffs only operate through the expenditure switching channel: relative price changes reallocate home and foreign output. Although monetary policy is temporarily constrained, this paper nests Caballero et al. (2021)'s results[1].

[1] In their paper, increasing the global tariffs does not change the global output or consumption. This point can be seen by combining equations 40a and 40b and assuming symmetric countries with exchange rate=1. In this symmetric setting, global demand is irrelevant to global tariff rates.

The idea of tariff stabilization is not new. Dixit and Norman (1980) talks about tariffs "at fixed wage, increase employment and hence income". This paper clearly shows the possibility of tariff stabilization and complements old narratives in a modern setting.

Jeanne (2018) analyzes multiple policy games including tariffs when the global economy has constrained monetary policy for one period. In Appendix D, he shows that increasing tariffs reduces consumption and improves the trade balance deflated by the global price level. Since welfare is measured on the level of consumption, his results in Table D2 imply that tariffs increase domestic consumption when IES <1=Armington elasticity and that the home country's tariffs always depress global and foreign consumption. This result directly implies that a global cooperative policy would not impose any positive tariffs and he argues that the global policymaker indeed set tariffs at a negative level. This paper complements Jeanne (2018) by showing that the effects of tariffs depend on how likely monetary policy remains constrained in the future.

2. Temporary tariffs under sticky prices

This section shows the channels through which tariffs transmit to consumption and output in an open-economy New Keynesian model with intermediate inputs in production under roundabout production. The small open-economy case is a starting point for analyzing the impact of import tariffs on the domestic economy. While permanent tariffs refer to protection expected to last forever, temporary tariffs are expected to be revoked with a positive probability. The next section discusses tariffs with spillovers. Throughout the model, lowercase variables denote log deviations from the deterministic steady state.

In sum, the model conveys two messages. First, a common argument against tariffs is that tariffs lower the real wage and hence depress consumption through the real income channel. This argument holds for permanent tariffs or trade policy under flexible prices, and consumption indeed falls under this channel. However, the overall effect on output depends on trade elasticity and the intertemporal elasticity of substitution. Second, unlike permanent tariffs, temporary tariffs change expected inflation. When tariffs are temporary, the real income channel is not present in the general class of representative-agent New Keynesian models because households in this class of models have a low marginal propensity to consume. As a result, the wealth effect of temporary protection is weak. A similar argument is made by Auclert et al. (2021).

Temporary tariffs affect expected inflation from both the supply and demand sides. On the supply side, temporary tariffs are inflationary because they raise marginal costs and compress the markup under sticky prices. Tariffs are deflationary on the demand side because households expect the CPI to be lower in the future as tariffs go away. Hence, the overall response of consumption in general equilibrium mainly operates through the real interest rate channel, where monetary policy and the slope of the Phillips curve affect expected inflation and hence the real interest rate. The response of output in turn depends on the level of expenditure and the expenditure-switching channel, coming from the direct effect of tariffs and the indirect effect of the terms-of-trade response.

Households' lifetime utility is $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$. For $\sigma = 1$, $U(C_t, N_t) = log(C_t) - \frac{N_t^{1+\psi}}{1+\psi}$ and for $\sigma \neq 1$, $U(C_t, N_t) = \frac{C^{1-\sigma}-1}{1-\sigma} - \frac{N_t^{1+\psi}}{1+\psi}$. Home-biased final consumption consists of home and foreign goods according to $C_t = \left((1-\nu)^{\frac{1}{\eta}} C_{H,t}^{\frac{1-\eta}{\eta}} + \nu^{\frac{1}{\eta}} C_{F,t}^{\frac{1-\eta}{\eta}}\right)^{\frac{\eta}{\eta-1}}$, where $\nu \in (0, 0.5)$ and $\eta \geq 1$. Tariff revenues T_t are transferred to households. Households save in state-contingent bonds D_{t+1}. $Q_{t,t+1}$ is the stochastic discount factor for one-period-ahead nominal payoffs. Households face the following budget constraint.

$$P_t C_t + \mathbb{E}_t(Q_{t,t+1} D_{t+1}) = D_t + W_t N_t + T_t + \Pi_t$$

Households' labor choice in a log-linearized form is $\sigma c_t + \psi n_t = w_t - p_t$. The CES aggregator implies the price index $p_t = (1-\nu) p_{H,t} + \nu(p_{F,t} + \tau_t)$, where τ_t is the tariff imposed by the home country on foreign goods, $p_{H,t}$ is the domestic producer price, and $p_{F,t}$ is the tariff-exclusive price of imported goods in local currency. To facilitate the interpretation of the result of tariffs on output, I consider a perfectly elastic labor supply, that is $\psi \to 0$. Households' labor supply becomes $\sigma c_t = w_t - p_t$. The log-linearized household Euler equation is

$$c_t = \mathbb{E}_t(c_{t+1}) - \frac{1}{\sigma}(i_t - \mathbb{E}_t(\pi_{t+1}))$$

Firms employ labor and use inputs X_t according to $Y_t = N_t^{1-\alpha} X_t^{\alpha}$. These inputs come from combining home and foreign final output using the same aggregation function for consumption bundles. Therefore, the price of inputs is the same as that of final consumption goods. Firms also face Calvo nominal frictions. Firms reset their optimal prices $\bar{P}_t$ with a probability $1 - \theta$ each period, where $\bar{P}_{H,t} = (1 - \beta\theta) E \sum_{j=t}^{\infty} (\beta\theta)^{j-t} [MC_j]$. The marginal cost is $MC_t = \frac{W_t^{1-\alpha} P_t^{\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}$. Firms' optimal labor demand is $W_t N_t = (1 - \alpha) MC_t Y_t$, and the optimal demand for inputs is $P_t X_t = \alpha MC_t Y_t$.

The goods market clearing condition is $Y_t = C_{H,t} + X_{H,t} + C_{F,t} + X_{F,t}$. In the steady state, the tariff-exclusive terms of trade defined as $S_t = P_{H,t}/P_{F,t}$ are one, and $C/Y = 1 - \alpha$ when a subsidy is applied to eliminate steady-state markups. The log-linearized goods market clearing condition is

$$y_t = (1 - \nu)((1 - \alpha)c_t + \alpha x_t) + \nu(2 - \nu)\eta s_t + \nu\eta(1 - \nu)\tau_t \tag{1}$$

The risk sharing condition under complete markets is

$$C_t = C_t^* \left(\frac{\mathcal{E}_t P_t^*}{P_t}\right)^{\frac{1}{\sigma}}$$

Once the Law of One Price is applied to express the real exchange rate $\frac{\mathcal{E}_t P_t^*}{P_t}$ as import prices relative to domestic consumer prices, $\frac{P_{F,t}}{P_t}$, and the equation is linearized, the risk-sharing condition can be represented using the terms of trade s_t as

$$\sigma c_t = \frac{\nu}{1 - \alpha}(s_t - \tau_t) \tag{2}$$

Finally, to close the model, monetary policy targets PPI inflation. The nominal interest rate i_t expressed as the deviation from the steady state is $i_t = \max(-r^n, \phi_\pi \pi_{H,t})$, where $\pi_{H,t} = p_{H,t} -$

$p_{H,t-1}$. The natural real interest rate is $r^n = -log(\beta)$.

2.1 Trade policy under flexible prices

When prices are flexible, the optimal labor supply choice $(1-\alpha)\sigma c_t = \nu s_t - \nu\tau_t$ and the risk sharing condition (eq. 2) pin down the effects of tariffs.

$$c_t = -\frac{\nu}{\sigma(1-(1-\nu)\alpha)}\tau_t \tag{3}$$

$$s_t = \frac{\nu\alpha}{(1-(1-\nu)\alpha)}\tau_t \tag{4}$$

Tariffs always depress consumption in a Neoclassical model because tariffs increase the domestic price level by raising the price of imports and lowering the real wage, which reduces labor demand. In other words, tariffs operate through the household real-income channel. However, tariffs have a positive effect on the terms of trade when inputs are used in production. The larger the input share in production, the more tariffs raise the terms of trade. The response of output is

$$y_t = \frac{\nu}{(1-(1-\nu)\alpha)^2}\left[(1-\nu-\alpha)\eta - (1-\alpha)(1-\nu)(\frac{1}{\sigma}+\alpha)\right]\tau_t$$

The response of output to tariffs depends on changes in expenditure levels from consumption and the reallocation of consumption between home and foreign goods due to terms of trade. Without inputs in production (i.e. $\alpha = 0$), tariffs directly raise output by inducing households to consume more domestic goods through expenditure switching. As a result of lower consumption, tariffs indirectly lower output. The expenditure switching effect dominates when $\eta > \frac{1}{\sigma}$. With inputs (i.e. $\alpha \in (0,1)$), tariffs improve domestic terms of trade and hence marginally reduce output by reducing domestic exports to the rest of the world. Therefore, a larger trade elasticity is required to amplify the expenditure switching effect directly from tariffs so that tariffs stimulate output.

The above results assume perfect risk sharing under complete markets. I analyze an example of an incomplete segmented international financial market as in Itskhoki and Mukhin (2021) and assume no intermediate goods in production (i.e. $\alpha = 0$). When international financial markets are segmented and a risk-averse arbitrageur trades local-currency bonds from this small open economy against foreign-currency bonds, the following three dynamic equations summarize the effects of tariffs.

$$\sigma c_t = \nu s_t - \nu \tau_t \tag{5}$$

$$\hat{b}_t^* = \frac{1}{\beta}\hat{b}_{t-1}^* + \underbrace{\left((\nu(1-2\eta+\nu\eta) - \frac{\nu^2}{\sigma}\right)}_{\kappa_s} s_t + \underbrace{\left(\frac{\nu^2}{\sigma} + \eta\nu(1-\nu)\right)}_{\kappa_\tau} \tau_t \tag{6}$$

$$\mathbb{E}_t\left(\sigma\Delta c_{t+1} - (1-\nu)\Delta s_{t+1} + \nu\Delta\tau_{t+1}\right) = -\omega\hat{b}_t^* \tag{7}$$

where $\hat{b}_t^*$ is related to the home country's net foreign asset position, and ω summarizes the risk aversion and the volatility of the exchange rate. Equation 7 is the balance of payment approximated to the first order, and equation 6 is the risk sharing condition. Under this incomplete market, the terms of trade s_t follows an ARMA(2,1) process such that

$$s_t = (\rho + \mu_1)s_{t-1} - \rho\mu_1 s_{t-1} + \hat{\chi}_1\epsilon_{\tau,t} - \hat{\chi}_2\epsilon_{\tau,t-1} \tag{8}$$

where $\mu_1 = \frac{1}{2}[(1-\omega\kappa_s + \frac{1}{\beta}) - \sqrt{(1-\omega\kappa_s+\frac{1}{\beta})^2 - \frac{4}{\beta}}] < 1$, ρ is the autoregressive coefficient of tariffs τ_t, $\epsilon_{\tau,t}$ is the tariff shock, $\hat{\chi}_1 = -\frac{\kappa_\tau}{\kappa_s}\frac{1-\beta\mu_1}{1-\beta\mu_1\rho}$, and $\hat{\chi}_2 = \mu_1 + \rho - 1$. Therefore, the response of consumption depends on the sign of

$$\sigma(1-\eta) - (\nu + \eta\sigma(1-\nu))\frac{\beta\mu_1(1-\rho)}{1-\beta\mu_1\rho}$$

Unlike the unambiguous decline in domestic demand under complete markets, consumption may rise with small trade elasticity $\eta < 1$ and large σ.

2.2 Temporary tariffs under PPI targeting monetary policy rule

This section focuses on the transmission of temporary tariff shocks under nominal frictions. The log-linearized model around the steady state can be summarized by the open-economy New Keynesian Phillips curve, the IS curve, and a monetary policy rule targeting domestic PPI inflation. Given exogenous tariffs τ_t, equations 9-11 define the equilibrium dynamics of consumption c_t, PPI inflation $\pi_{H,t}$, and the nominal interest rate i_t. In order to highlight how temporary tariffs facilitate intertemporal trade, the IS curve is expressed using consumption instead of output.

$$\pi_{H,t} = \beta \mathbb{E}_t(\pi_{H,t+1}) + \lambda \left(\sigma(\frac{1}{1-\nu} - \alpha) c_t + \frac{\nu}{1-\nu} \tau_t \right) \tag{9}$$

$$c_t = \mathbb{E}_t(c_{t+1}) - \frac{1-\nu}{\sigma} \big(i_t - \mathbb{E}_t(\pi_{H,t+1}) - \frac{\nu}{1-\nu} \mathbb{E}_t(\Delta \tau_{t+1}) \big) \tag{10}$$

$$i_t = \max\{-r^n, \phi_\pi \pi_{H,t}\} \tag{11}$$

where λ comes from Calvo sticky prices and governs the slope of the Phillips curve. ϕ_π governs the response of monetary policy to domestic PPI inflation.

Two competing forces of tariff shocks exert influence on inflation through the New Keynesian Phillips and IS curves, respectively. Unlike commonly observed shocks that affect only either the supply or demand side, the level of tariffs enters the New Keynesian Phillips curve (eq. 9), and expected tariffs enter into the IS curve (eq. 10). On the supply side, tariffs generate inflation. On the demand side, an expected drop in tariffs lowers expected inflation and hence raises the consumption-based natural real interest rate while depressing current consumption.

The effects of tariffs crucially depend on $\mathbb{E}_t(\Delta \tau_{t+1})$. The following two types of tariffs have identical effects: 1) Any temporary tariff shocks that follow an AR(1) process with the autoregressive coefficient ρ; 2) Tariffs that have a probability ρ of reverting to previous levels. The central message is that as long as future tariffs are expected to be lowered, a trade policy meant to be permanent affects inflation expectations in general equilibrium. For example, before China's admission to the WTO, the U.S. import tariffs on Chinese goods were reviewed regularly, implying that expected inflation also affected the impact of the U.S. trade policy towards China. Moreover, Trump's tariffs on Chinese goods were maintained for many years, and Trump's tariff shocks did not follow an autoregressive process. However, the public was uncertain about whether or not Trump's tariffs would remain in place forever.

In general equilibrium, tariffs generate inflation, despite a negative response in consumption. Domestic PPI inflation is

$$\frac{d\pi_{H,t}}{d\tau_t} = \frac{\nu\lambda(1-\rho)\alpha}{\mathcal{M}}, \text{ where } \mathcal{M} = (1-\beta\rho)(1-\rho) + \lambda(\phi_\pi - \rho)(1-\alpha(1-\nu)) > 0$$

Tariffs necessarily increase the real interest rate and depress consumption on the demand side, and the extent to which this generates deflation depends on the slope of the Phillips curve. The curve is flattened when the share of inputs in production rises.

The response of consumption to tariffs in general equilibrium is

$$\frac{dc_t}{d\tau_t} = -\frac{\nu\sigma^{-1}}{\mathcal{M}}\left\{\lambda(\phi_\pi - \rho) + (1-\rho)(1-\beta\rho)\right\} < 0 \tag{12}$$

Tariffs always depress consumption because $\phi_\pi > 1$ is required for a stable equilibrium. Throughout the paper, consumption instead of output gaps enters into the IS curve. The reason for writing the IS curve in this way is to isolate the effect of tariffs on domestic demand. In fact, the unambiguous fall in consumption in this model is a distinct feature of it, and the results that follow discuss ways to break this result.

The direct response of consumption to anticipated lower tariffs is the dominant force and is independent of household inter-temporal consumption motives (i.e. σ does not affect the sign of the response of consumption to tariffs). This result occurs because any small IES would imply a small direct response of current consumption on the demand side, but a small IES also implies a large substitution between consumption and labor supply, which leads to a steeper Phillips curve and larger expected deflation from tariffs. In general equilibrium, the supply- and demand-side effects from household intertemporal consumption smoothing motives cancel out. Therefore, σ

does not affect of the sign of equation 12.

Moreover, monetary policy responds to domestic PPI inflation, reducing expected inflation from tariffs and further amplifying the negative effects of tariffs on consumption. Due to the simplifying assumption of perfectly elastic labor supply, the impact of tariffs on output depends on aggregate consumption, the expenditure switching effect from terms of trade, and the direct response of tariffs, as shown by

$$
\begin{aligned}
y_t &= \frac{1}{1-(1-\nu)\alpha}\left[(1-\nu)(1-\alpha)(1+\alpha\sigma)c_t - \nu\eta(2-\nu)s_t + \nu\eta(1-\nu)\tau_t\right] \\
&= \frac{1}{1-(1-\nu)\alpha}\left[((1-\nu)(1-\alpha)(1+\sigma\alpha) + \frac{\eta\nu(2-\nu)\sigma}{1-\nu})c_t + \frac{\nu\eta}{1-\nu}\tau_t\right]
\end{aligned}
$$

Tariffs improve the terms of trade, and hence the expenditure switching effect directly from tariffs is the only source of rising output.

3. Temporary tariffs under alternative monetary policy

Previous results show that with a monetary policy rule controlling the producer level inflation, tariffs increase the consumption-based real interest rate and hence depress the current consumption. A natural question is considering results under different degrees of monetary policy accommodations to inflation. I consider a strict inflation targeting and an inactive monetary policy when the economy is at the zero interest rate lower bound or under a currency peg.

3.1 A strict inflation targeting

A possible monetary policy rule is that the monetary authority maintains a strict inflation target regardless of the path of trade policy. The choice of a producer-level or a consumer-level inflation target determines the equilibrium allocations. For simplicity, suppose that the inflation target for CPI inflation is zero. Then, with $\mathbb{E}_t(\pi_t) = 0$, temporary protection does not affect the economy through the dynamic IS curve. Like permanent tariffs, the labor supply choice and the risk-sharing condition determine the equilibrium allocations.

When the targeted PPI inflation is zero, the CPI index will experience deflation because households anticipate the price will fall in the future. This implies that the consumption-based real interest rate will be higher, and current consumption is reduced to the point where the deviation of consumption from the steady state exactly offsets the positive tariffs so that the producer price is unchanged each period. In other words, consumption can be solved through the Phillips curve to ensure $\pi_{H,t} = \mathbb{E}(\pi_{H,t+1}) = 0$, that is

$$c_t = -\frac{\nu}{\sigma(1-\alpha(1-\nu))}\tau_t < 0$$

In sum, regardless of the inflation target, tariffs under strict inflation targeting always reduce consumption.

3.2 Tariffs at the zero interest rate lower bound and under currency peg

This section analyzes the case in which the nominal interest rate in the economy is fixed regardless of the trade policy. This happens when the economy is under an extreme disruption of the financial sector such that the monetary authority lowers the nominal interest rate but is constrained by the zero lower bound. I adopt the approach used to analyze the fiscal spending multiplier under the zero lower bound by Woodford (2011). The economy experiences two states. Whenever the economy is under the zero lower bound, tariffs are imposed. The economy is anticipated to escape the zero lower bound with a probability $\mu > 0$. Once this happens, tariffs are removed. Therefore, when the economy does not experience any uncertainty, it should return to the steady state. In this case, tariffs are anticipated to be in place with a probability $\rho = \mu$. The effect of tariffs on consumption is

$$\frac{dc_t}{d\tau_t} = -\frac{\nu}{\sigma}\frac{(1-\beta\rho)(1-\rho)-\lambda\rho}{\mathcal{N}} \tag{13}$$

The stability condition requires that $\mathcal{N} = (1-\beta\rho)(1-\rho) - \lambda\rho(1-\alpha(1-\nu)) > 0$. There is an upper bound $\bar{\rho} < 1$ such that $\rho < \bar{\rho}$. Moreover, there exists ρ such that consumption rises because the term in the numerator $1-\alpha(1-\nu) < 1$.

Tariffs increase consumption by generating expected inflation and lowering the natural real interest rate in equilibrium. Since monetary policy is inactive, a high probability of tariffs remaining in place is required to generate enough expected inflation to offset the negative effects of anticipated future lower tariffs (expected deflation).

The derivation in this section clarifies the results in Barattieri et al. (2018). They recognize tariffs as being inflationary and the negative effects of monetary policy, but they do not clearly articulate the direct effect of anticipated lower tariffs due to the shock process being AR(1) on distorting intertemporal consumption. The negative anticipated effects of tariffs also carry over to their analysis of constrained monetary policy. What they fail to recognize is that tariffs may stabilize consumption and output in a small open economy as the likelihood of monetary policy being constrained in the future increases.

Moreover, perfect risk sharing implies that the terms of trade worsen when tariffs increase consumption. Hence, regardless of parameters, output increases due to higher consumption and expenditure switching toward home goods by home consumers and larger exports due to a lower terms of trade.

A fixed nominal interest rate can also occur when the country has a fixed exchange rate regime by pegging its currency to another country. With free capital mobility, this implies that this country is importing foreign monetary policy. The effect of temporary tariffs on consumption is

$$\frac{dc_t}{d\tau_t} = \frac{\lambda\nu - (1-\beta\rho)\frac{1}{\sigma}(\lambda\nu + \nu(1-\rho)\beta}{\mathcal{G}} \tag{14}$$

where $\mathcal{G} = (1-\beta\rho)(\lambda(1-\alpha(1-\nu)) + \beta(1-\rho)) - \lambda(1-\alpha(1-\nu))$. Stability requires $\mathcal{G} > 0$. Although the sign of the effect of tariffs on consumption is ambiguous, it can be shown that there always exists $0 < \rho < 1$ such that the numerator is greater than zero when $\lambda + \beta > 1$. This is consistent with the intuition that, when the nominal interest rate in the economy does not respond to inflation, temporary tariffs could improve consumption. Moreover, it is worth noting that the share of intermediate inputs in production does not play any role in the above results. With spillover effects, this result does not hold.

4. Spillovers of trade policy in the global economy

This section focuses on tariffs imposed by countries that affect international prices. As before, lowercase variables represent the log deviation from the steady state. The superscript W denotes variables for the world aggregate.

4.1 Coordinated tariffs and global welfare

For permanent tariffs, the world labor and goods markets clearing conditions pin down world aggregate consumption c_t^W.

$$\frac{dc_t^W}{d\tau_t^W} = -\frac{\nu}{\sigma}$$

An increase in world tariff rates reduces global consumption (output) due to the negative employment effects of higher real wages. This result is similar to the small open economy case analyzed above.

With nominal frictions and a monetary policy rule targeting PPI inflation, the equilibrium for the world can be defined as follows.

$$\pi_t^W = \beta\mathbb{E}_t(\pi_{t+1}^W) + \lambda(\sigma(1-\alpha)c_t^W + \nu\tau_t^W), \text{ where } \pi_t^W = \pi_{H,t} + \pi_{F,t}^* \tag{15}$$

$$c_t^w = \mathbb{E}_t(c_{t+1}^w) - \frac{1}{\sigma}(i_t^W - \mathbb{E}_t(\pi_{t+1}^w) - \nu\mathbb{E}_t(\Delta\tau_{t+1}^W)) \tag{16}$$

$$i_t^W = \max\{-r^W, \phi_\pi\pi_t^W\}, \text{ where } i_t^W = i_t + i_t^*, \quad r^W = 2r^n \tag{17}$$

$$y_t^W = (1+\alpha\sigma)c_t^W \tag{18}$$

Similar to the small open economy case, tariff shocks enter both the New Keynesian Phillips curve and the IS curve. Tariffs increase both worldwide current and expected PPI inflation, and hence exert downward pressure on the natural real interest rate, boosting current consumption. However, in the presence of a monetary policy rule targeting inflation, monetary policy reacts to a rise in current inflation. Therefore, the effect of tariffs on boosting current consumption and output is mitigated by the monetary policy. Moreover, any trade policy that elicits an expectation of lower future tariffs increases the natural real interest rate and depresses current consumption. The effect of tariffs on global consumption is:

$$\frac{dc_L^w}{d\tau_L^w} = -\frac{\nu}{\sigma} \times \frac{(1-\rho)(1-\beta\rho)+\lambda(\phi_\pi-\rho)}{(1-\rho)(1-\beta\rho)+\lambda(\phi_\pi-\rho)(1-\alpha)} < 0$$

When monetary policy is inactive, tariffs are reversed to the steady state level with a probability of $1-\rho$. The effect of tariffs on global consumption becomes:

$$\frac{dc_L^w}{d\tau_L^w} = -\frac{\nu}{\sigma} \times \frac{(1-\rho)(1-\beta\rho)-\lambda\rho}{(1-\rho)(1-\beta\rho)-\lambda\rho(1-\alpha)}$$

where the existence of a solution requires $(1-\rho)(1-\beta\rho)-\lambda\rho(1-\alpha) > 0$. There is an upper bound $\bar{\rho} < 1$ that satisfies this condition. The term $\lambda\rho$ governs expected inflation from tariffs, while the term $(1-\rho)(1-\beta\rho)$ governs expected deflation from anticipated lower tariffs once the economy returns to the steady state. When these two terms offset each other, the state of the economy is similar to what Caballero et al. (2021) describe: tariffs are zero-sum.

As long as inputs are used in production (i.e. $1 > \alpha > 0$), there exists $\rho < \bar{\rho}$ such that tariffs potentially raise global consumption and output. Households expect tariffs to be lower once preference shocks end, and anticipated lower future tariffs depress current consumption and generate expected deflation through the Phillips curve. However, when the Phillips curve is flat, expected deflation is small. Self-oriented tariffs increase global demand by increasing world inflation.

The novel result from the analytical expression is that the presence of the zero lower bound in the world economy does not guarantee that tariffs increase world consumption and thereafter world output. Without intermediate inputs in production $\alpha = 0$, world output always *falls*.

In terms of welfare, I focus on a specific case where monetary policies around the world are constrained by the zero lower bound. The welfare analysis focuses on this case because monetary policy (or even fiscal policy) is able to manage demand when tariffs as a tool cannot do better. When monetary policy is unable to stimulate demand, tariffs may generate expected inflation and allow the economy to escape the liquidity trap. However, Jeanne (2018) does not support this argument, and shows that the optimal coordinated tariffs under a global liquidity trap are actually negative.

Here, I use a two-state economy and assume that the economy is expected to return to the steady state in the next period with a probability ρ. Tariffs are imposed whenever the global economy is in the liquidity trap. I further assume that the demand shock is large enough so that tariffs alone do not allow the economy to escape the liquidity trap. I show that using tariffs or not depends on the production structure and the expected persistence of tariffs (or how long the economy remains in the liquidity trap).

To conduct the welfare analysis, I first compute the optimal consumption and labor supply from the global social planner's point of view and then use a second-order approximation of the world utility function around the social optimum.

The welfare that the global social planner optimizes is

$$\mathbb{W} = \frac{1}{1-\beta\rho}\left(\frac{2(1+\alpha\phi+\alpha)}{1+\alpha\phi}c_L^W - \frac{\epsilon}{4\lambda(1+\alpha\phi)}\pi_L^{W2} - \frac{(1+\phi)(1+2\alpha+\phi\alpha)^2}{4}c_L^{W2}\right)$$

where ϵ is the elasticity of substitution among differentiated varieties, and ϕ is the inverse of the Frisch labor supply elasticity.

The subscript "L" denotes the value under the global liquidity trap. Its response to tariffs is identical to the case under inactive monetary policy described above. It can be shown that if $dc_L^W/d\tau_L < 0$, then the optimal tariffs must be smaller than zero. In other words, under a global liquidity trap, the social planner would subsidize imports instead of imposing import tariffs.

Moreover, this must be the case when production does not use intermediate inputs (i.e. $\alpha = 0$).

Figure 1 depicts the value of the optimal world tariffs determined by the social planners. It shows that when the persistence of the liquidity trap is low, optimal tariffs are negative. When the persistence is large enough, there exist cases where optimal tariffs are positive. Overall, the use of the tariffs, even under a global liquidity trap by the social planner, depends on the anticipated length of the liquidity trap and the global production structure. It is possible that coordinated tariffs improve welfare in a global liquidity trap.

4.2 Spillover effects of unilateral tariffs

To analyze the spillover effects of tariffs, I define variables in relative terms. The superscript R denotes variables for the home country relative to the foreign country.

$$y_t^R = \frac{(1+\alpha\sigma)(1-\alpha)}{1-\alpha+2\nu\alpha}(1-2\nu)c_t^R + \frac{2\nu\eta(1-\nu)}{1-\alpha+2\nu\alpha}\tau_t^R - \frac{4\eta\nu(1-\nu)}{1-\alpha+2\nu\alpha}s_t$$

$$\pi_t^R = \beta\mathbb{E}_t(\pi_{t+1}^R) + \lambda((1-\alpha)\sigma c_t^R + \nu\tau^R - 2\nu s_t)$$

$$c_t^R = \mathbb{E}_t(c_{t+1}^R) - \frac{1}{\sigma}(i_t^R - \mathbb{E}_t(\pi_{t+1}^R) + 2\nu\mathbb{E}_t(\Delta s_{t+1}) - \nu\mathbb{E}_t(\Delta\tau_{t+1}))$$

$$s_t = -\frac{\sigma}{1-2\nu}c_t^R - \frac{\nu}{1-2\nu}\tau_t^R$$

$$i_t^R = \max\{0, \phi_\pi\pi_t^R\}, \text{ where } i_t^R = i_t - i_t^*$$

When the monetary policy is active, the relative consumption is

$$\frac{dc_t^R}{d\tau_t} = -\frac{\nu}{\sigma} \times \frac{(1-\rho)(1-\beta\rho) + \lambda(\phi_\pi - \rho)}{(1-\rho)(1-\beta\rho) + \lambda(\phi_\pi - \rho)((1-\alpha)(1-2\nu)+2\nu)} < 0$$

Using the definition of c_t and c_t^*, I find that $\frac{dc_t}{d\tau_t} < 0$, but $\frac{dc_t^*}{d\tau_t} > 0$. Moreover, from relative consumption, the terms of trade appreciate when the home country imposes tariffs. Regarding relative output, lower home consumption relative to foreign consumption depresses the overall level of consumption, and terms-of-trade appreciation depresses the home country's exports. The home country's output can only benefit from the expenditure switching effects directly resulting from higher import prices due to tariffs.

In the absence of inputs in production, if the trade elasticity is high enough such that $\eta\sigma(1-\nu) > 1$, then this expenditure-switching effect can induce a rise in the home country's output relative to the foreign country, an increase in home output, and a fall in foreign output. In other words, the home country's tariffs are able to stabilize domestic production, though they depress domestic consumption as well as foreign output.

When monetary policy is inactive, there exists $\bar{\rho}$ such that $(1-\rho)(1-\beta\rho) - \lambda\rho((1-\alpha)(1-2\nu)+2\nu) > 0$ and for any $\rho < \bar{\rho}$,

$$\frac{dc_t^R}{d\tau_t} = -\frac{\nu}{\sigma} \times \frac{(1-\rho)(1-\beta\rho) - \lambda\rho}{(1-\rho)(1-\beta\rho) - \lambda\rho((1-\alpha)(1-2\nu)+2\nu)} \tag{19}$$

Since $(1-\alpha)(1-2\nu)+2\nu < 1$, there exists $\rho < \bar{\rho}$ such that $\frac{dc_t^R}{d\tau_t} > 0$. This means tariffs could raise home-relative consumption. In fact, tariffs also increase home consumption at the expense of reducing foreign consumption. Regarding the response of output, a terms-of-trade depreciation facilitates expenditure switching. Overall, the transmission of tariffs to the home country's output differs completely depending on monetary policy.

When monetary policy actively manages inflation, the positive effect of tariffs on output comes from the direct effect of tariffs on expenditure switching and higher foreign consumption, which increases the export demand for the home country's goods. When monetary policy is inactive, in addition to the previous direct effects of tariffs, tariffs indirectly reallocate global demand from the foreign country to the home country. Moreover, the terms of trade depreciate in equilibrium, further facilitating expenditure switching to domestic goods. For the foreign country, when monetary policy is inactive, the home country's tariffs stimulate output at the expense of foreign output.

Could tariffs improve the home country's consumption or output without a beggar-thy-neighbor effect? First of all, the necessary condition for a positive spillover effect of tariffs is that a rise in worldwide aggregate tariffs raises global demand. This could happen when monetary policy is inactive and when a sufficiently large share of inputs is used in production.

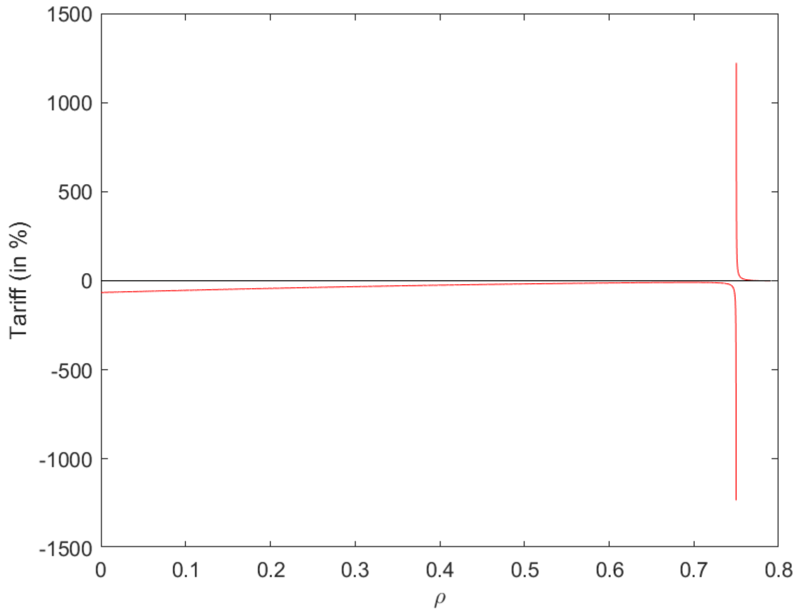
I show that within this framework and with realistic parameters, the home country's tariffs could stimulate both the home and the foreign country's output. To demonstrate this, I first choose the following baseline parameters: risk aversion $\sigma = 1$, trade openness $\nu = 0.2$, input share in production $\alpha = \frac{2}{3}$, and trade elasticity $\eta = 1$. I change the value of one parameter while holding the others at the baseline level. In each sub-figure of Figure 2, I change the value of one parameter while holding the others at the baseline level. I shade the parameter ranges where output increases for both the home and the foreign country in response to the home country's tariffs under a constrained monetary policy.

Once the home country imposes tariffs, tariffs generate a terms-of-trade depreciation. This reallocates global demand to the home country on top of the direct effect of tariffs. Consumption in both countries rises due to an increase in expected inflation globally and a lower real interest rate. The positive expenditure switching effect and higher expenditure level in the home country contribute to an increase in the home country's output. The positive expenditure switching effect for the home country works against the foreign country and directly lowers foreign output. However, higher global consumption generates a positive force for foreign output. Due to the presence of inputs in production, higher home country production requires more imports from the foreign country and boosts foreign output. Overall, relative price changes reduce foreign output, but this effect is outweighed by higher expenditure levels in the foreign country, increased import demand from the home country for consumption and production. In fact, the home country's tariffs deteriorate its trade balance when they generate positive spillovers.

5. Conclusion

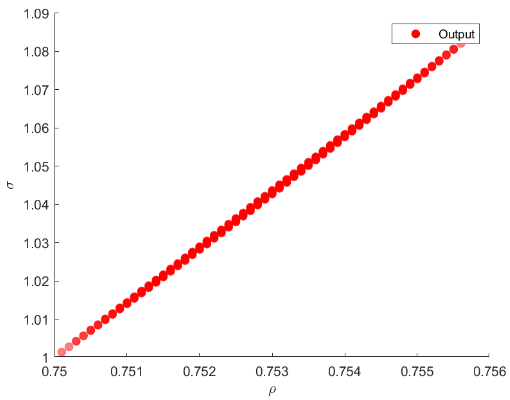
This paper examines temporary tariff policies in a sticky-price environment. It shows analytically how trade policy interacts with monetary policy and highlights the importance of trade openness, intertemporal and intratemporal trade elasticities, and intermediate inputs. Tariff shocks enter both the open-economy IS curve and the Phillips curve. An inactive monetary policy, along with a flat Phillips curve influenced by inputs in production, amplifies the inflationary effects of tariffs. A self-oriented trade policy in small open economies may raise domestic consumption, promote exports through a depreciated terms of trade, and ultimately stimulate output. These stimulus effects also apply to large economies but generally come at the cost of foreign consumption or output. However, when the input share in production is sufficiently large, a large country's self-oriented trade policy may benefit the domestic economy without negatively impacting foreign consumption or output.

Figure 1: Optimal coordinated tariffs under constrained monetary policy

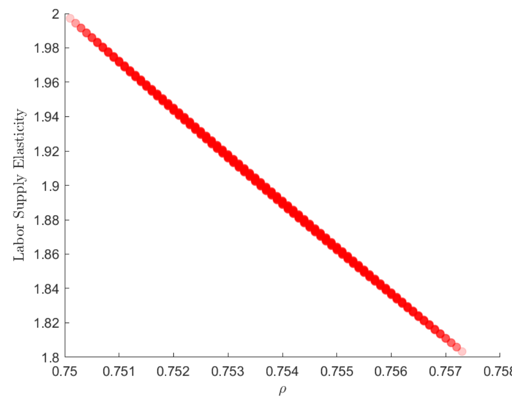


Notes: The parameters used to generate this figure are: $\beta = 0.99$, $\nu = 0.2$, $\eta = \sigma = \phi = 1$, $\alpha = \frac{2}{3}$, and $\epsilon = 6$.

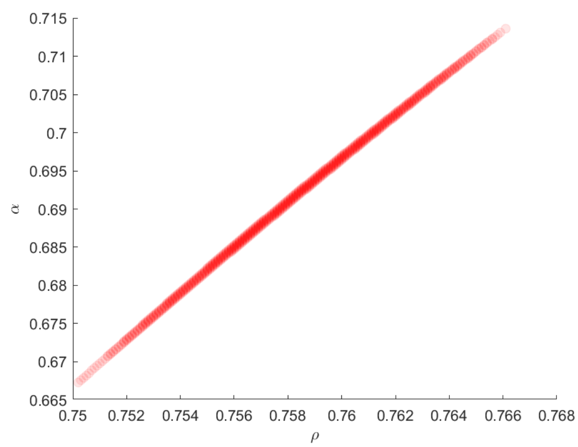
Figure 2: Positive effects of home tariffs on both the home and foreign countries under constrained monetary policy



(a) Varying σ



(b) Varying labor supply elasticity



(c) Varying α

Notes: This figure illustrates the possibility of home tariffs increasing both home and foreign output. These positive spillovers from home tariffs depend on four key parameters and the probability of the economy remaining under constrained monetary policy. The baseline key parameters are labor supply elasticity=0.5, $\nu = 0.2, \alpha = \frac{2}{3}, \eta = 1$. Each sub-figure varies one baseline parameter.

References

Auclert, Adrien, Matthew Rognlie, Martin Souchier, and Ludwig Straub, “Exchange rates and monetary policy with heterogeneous agents: Sizing up the real income channel,” Technical Report, National Bureau of Economic Research 2021.

Auray, Stephane, Michael B Devereux, and Aurelien Eyquem, “The Demand for Trade Protection over the Business Cycle,” 2020.

Auray, Stéphane, Michael B Devereux, and Aurélien Eyquem, “Trade Wars, Currency Wars,” July 2020.

Barattieri, Alessandro, Matteo Cacciatore, and Fabio Ghironi, “Protectionism and the Business Cycle,” February 2018.

Caballero, Ricardo J, Emmanuel Farhi, and Pierre-Olivier Gourinchas, “Global Imbalances and Policy Wars at the Zero Lower Bound,” *The Review of economic studies*, November 2021, *88* (6), 2570–2621.

Dixit, Avinash and Victor Norman, *Theory of International Trade: A Dual, General Equilibrium Approach*, Cambridge University Press, September 1980.

Eggertsson, Gauti B, Neil R Mehrotra, Sanjay R Singh, and Lawrence H Summers, “A Contagious Malady? Open Economy Dimensions of Secular Stagnation,” June 2016.

Erceg, Christopher, Andrea Prestipino, and Andrea Raffo, “Trade policies and fiscal devaluations,” http://andreaprestipino.com/pdfs/EPR_AEJ_SUBMISSION.pdf 2022. Accessed: 2022-5-27.

Itskhoki, Oleg and Dmitry Mukhin, “Exchange Rate Disconnect in General Equilibrium,” *The journal of political economy*, August 2021, *129* (8), 2183–2232.

Jeanne, Olivier, “Currency wars, trade wars and the global demand,” 2018.

Lorenzoni, Guido, “Do Tariffs Reduce The Trade Deficit?,” 2019.

Schmitt-Grohé, Stephanie, Martín Uribe, and Michael Woodford, *International Macroeconomics: A Modern Approach*, Princeton University Press, September 2022.

Woodford, Michael, “Simple Analytics of the Government Expenditure Multiplier,” *American Economic Journal: Macroeconomics*, January 2011, *3* (1), 1–35.