The Optimal Monetary Policy Response to Tariffs*

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Abstract

What is the optimal monetary policy response to tariffs? We address this question in a dynamic small open-economy New Keynesian model with unilateral tariffs. Tariffs affect output through a labor-supply channel that operates even absent movements in exchange rates or the terms of trade. The Ramsey optimal response is expansionary, with inflation rising above and beyond the direct effects of tariffs. The reason is a fiscal externality: households do not internalize that higher imports raise tariff revenue and aggregate income, so imports contract inefficiently. Optimal policy therefore overheats the economy, raising output above its natural level—and potentially above its *efficient* level. Under the Ramsey policy, the nominal exchange rate depreciates and the trade balance improves even when tariffs are permanent, contrary to the conventional view.

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1 Introduction

The rise in tariffs in the United States has sparked a debate about their inflationary consequences and the Federal Reserve's appropriate response. One view holds that the Federal Reserve should tighten monetary policy to keep inflation in check. Another view holds that the Federal Reserve should "look through" the tariff-induced inflation, as it reflects a one-off jump in the price level and therefore warrants no change in the monetary stance.[1]

This paper examines the optimal monetary policy response to a tariff shock and shows that the optimal response is expansionary. The reason is a fiscal externality: individual agents fail to internalize that higher imports raise tariff revenue and aggregate income, leading imports to contract excessively. By raising employment and income, monetary stimulus partially offsets this inefficient contraction—and, under plausible conditions, does so strongly enough to push output above not only its natural level but also its *efficient* level. The resulting monetary expansion depreciates the nominal exchange rate and narrows the trade deficit, even when the tariff is permanent. These predictions contrast with the traditional view, rooted in the Mundell–Fleming framework.

We present a dynamic, open-economy New Keynesian model with home-produced and imported goods. In the baseline model, imported goods are final consumption goods and international relative prices are exogenous; we then extend the analysis to settings in which imports serve as intermediate inputs and relative prices are endogenous to domestic output. Absent tariffs, the optimal policy follows the canonical New Keynesian prescription whereby the monetary authority implements an allocation with zero inflation and a zero output gap.

Tariffs create a fiscal externality: because tariff revenue is rebated, the private cost of imports exceeds their social cost, leading households to import too little. Stabilizing inflation therefore no longer implements the efficient allocation—divine coincidence fails. At the zero-inflation allocation, a marginal monetary expansion entails only second-order stabilization costs but raises income and imports, producing a first-order welfare gain. The Ramsey policy consequently overheats the economy, raising inflation above zero and employment above its natural level. Like a textbook cost-push shock, the tariff confronts the monetary authority with a tradeoff—but it leads to a distinct prescription: instead of holding output below its efficient level (Galí, 2015), optimal policy pushes output *above* it whenever the intertemporal elasticity of substitution is below one.

[1] For these opposing views, see remarks by Governor Adriana Kugler (Kugler, 2025), who stated, "It should be a priority to make sure that inflation doesn't move up," and the speech by Governor Chris Waller (Waller, 2025a), who stated, "If, as I expect, tariffs do not have a significant or persistent effect on inflation, they are unlikely to affect my view of appropriate monetary policy."

Our analysis challenges conventional wisdom on the effects of tariffs on exchange rates and capital flows. The conventional view, rooted in the Mundell–Fleming framework, holds that tariffs appreciate the exchange rate; moreover, if the tariff is permanent, it leaves the trade balance unchanged. In contrast, our model shows that under the optimal monetary policy, the nominal exchange rate depreciates following the imposition of tariffs, and even permanent tariffs result in a reduction in the trade deficit. The mechanism is that an expansionary monetary stance weakens the currency and, by lifting employment in the short run, induces households to accumulate foreign assets. Consistent with our results—and in contrast to the conventional view—the dollar depreciated against a broad currency basket following the Trump administration's April 2, 2025, tariff announcement.

We begin by characterizing the macroeconomic effects of tariffs in the flexible-price allocation, or equivalently, under a monetary policy that "looks through," stabilizing producer price index (PPI) inflation while allowing a one-time jump in the consumer price index (CPI). Unlike in a one-sector model, tariffs generate two distinct substitution margins: (i) between consumption of home and foreign goods, and (ii) between labor supply and consumption of foreign goods. When home and foreign goods are complements in utility—so that the marginal utility of home goods falls as imports decline—employment strictly decreases with tariffs. When they are substitutes, there exists a threshold tariff above which employment may increase. For empirically plausible values, we find that tariffs reduce employment in the flexible-price allocation. Thus, under a look-through monetary policy, tariffs lead to a recession and a one-time increase in the price level (i.e., an increase in CPI inflation on impact). Notably, the contraction in output occurs even absent movements in the terms of trade or the nominal exchange rate.

We then turn to the analysis of optimal policy. We begin the theoretical analysis with a version of the model in which firms face price adjustment costs that are rebated to households and thus do not entail resource losses. We characterize the solution in closed form and compare it with the natural allocation. We show that the sign of the employment response to a tariff under optimal policy depends entirely on the intertemporal elasticity of substitution (IES). Specifically, employment rises when the IES is below one, falls when it is above one, and is unaffected when it equals one. The case with the IES below one is noteworthy because optimal policy entails expanding output not only above the natural level but also above the *efficient* level. In this regard, the response to tariffs differs fundamentally from the canonical cost-push shock, under which the central bank unambiguously contracts output below the efficient level to contain inflation.

The optimal policy response to a tariff also differs fundamentally from the response to a

terms-of-trade shock. When the economy experiences a terms-of-trade shock, such as a rise in oil or food prices, the monetary authority finds it optimal to fully stabilize PPI inflation, as highlighted in existing studies, while letting the CPI jump (e.g., Aoki, 2001; Schmitt-Grohé and Uribe, 2001; Hevia and Nicolini, 2013). In this case, the increase in import prices reflects a genuine rise in the social cost of foreign goods, so there is no reason to deviate from the flexible-price allocation. In the case of a tariff, however, the increase in import prices reflects only a private cost, as tariff revenues are rebated to households, creating a fiscal externality that makes it desirable for the monetary authority to stimulate the economy to offset the decline in imports.

We conduct a quantitative analysis of the model calibrated to the U.S. economy. We consider the standard New Keynesian specification where price adjustment costs entail resource losses and calibrate these costs to be consistent with an estimated slope of the Phillips curve. In response to a permanent 15% tariff, employment rises slightly above its efficient level on impact under the optimal policy and then falls over time, while the natural (flexible-price) level of employment falls immediately and permanently by about 2.4%. PPI inflation under the optimal policy reaches about 0.2% annualized and converges to zero in the long run.

We explore several extensions of the baseline framework to assess the robustness of our results. First, we vary the duration and timing of the tariff shock. Temporary tariffs generate more pronounced movements in capital flows, while the anticipation of future tariffs poses a more delicate dilemma for the monetary authority, since an expansionary policy inefficiently boosts imports before the tariff is implemented. Second, we introduce imported intermediate inputs into production. In this case, tariffs directly raise marginal costs, strengthening the case for monetary accommodation: employment rises by more on impact as policy offsets higher production costs. Third, we extend the framework to allow for endogenous terms of trade, so that tariffs and monetary policy influence international prices. This channel dampens the required policy response to an inefficient increase in tariffs, but our main quantitative conclusions remain largely unchanged.

We also examine a scenario in which the economy begins from a distorted steady state. Specifically, we consider a setting where the standard subsidy to offset the markup is not in place and tariff revenue is used to subsidize labor. In this case, the optimal policy remains expansionary, but inflation is significantly attenuated. Moreover, we show that small tariffs are welfare-improving. Starting from a steady state with positive markups and zero tariffs, raising tariffs to finance labor subsidies generates a first-order gain by increasing employment, while inducing only a second-order loss by distorting trade.

To summarize, the paper makes three main contributions. First, we characterize Ramsey optimal monetary policy in response to an exogenous tariff shock and show that it is expansionary: the tariff revenue creates a fiscal externality that renders imports inefficiently low, and monetary stimulus partially offsets this distortion. Second, we characterize when tariffs contract or expand employment under alternative policy regimes, highlighting a labor-supply channel distinct from exchange-rate and terms-of-trade mechanisms. Third, we derive positive implications for exchange rates and external adjustment—highlighting how tariffs can induce a nominal depreciation and a reduction in trade deficits even for permanent tariffs—and show these results are robust across key extensions.

Related Literature. The role of tariffs as a macroeconomic policy tool dates back at least to Keynes (1937), who argued that protectionist measures could help stabilize employment under a fixed exchange rate system. Mundell (1961) showed that tariffs can become contractionary under a flexible exchange rate regime. In Mundell's model, a tariff boosts domestic demand, but the exchange rate appreciation offsets this stimulus by improving the terms of trade and raising savings (see also Krugman, 1982).

Following these classic studies and early work by Eichengreen (1981) and Razin and Svensson (1983), recent research has revisited the macroeconomic effects of tariffs through the lens of dynamic intertemporal frameworks. One strand of this literature has examined the effects of tariffs on exchange rates and employment using open economy New Keynesian models (Ambrosino, Chan and Tenreyro, 2024; Barattieri, Cacciatore and Ghironi, 2021; Comin and Johnson, 2021; Cuba-Borda et al., 2024; Eichengreen, 2019; Erceg, Prestipino and Raffo, 2023; Jeanne and Son, 2024).[2] Our main contribution is to characterize optimal policy; we also derive when tariffs contract or expand output across monetary regimes and identify a labor-supply channel that operates even without movements in exchange rates or the terms of trade.

A second strand of the literature examines the interaction between optimal monetary policy and trade policy. Much of this work focuses on the joint design of optimal tariffs and monetary policy. Auray, Devereux and Eyquem (2022, 2024, 2025) examine, respectively, how the cyclicality of optimal tariffs varies over the business cycle depending on the exchange rate regime, how different monetary policy regimes affect the intensity of trade wars, and how

[2] Rodríguez-Clare, Ulate and Vasquez (2026) consider a rich quantitative model of trade with nominal rigidities, but abstract from trade policy. Recent work at the intersection of trade policy and international macroeconomics includes Barbiero et al. (2019), Lindé and Pescatori (2019), and Costinot and Werning (2019) on Lerner symmetry; Steinberg (2019), Caldara et al. (2020), and Alessandria et al. (2025b) on trade-policy uncertainty; and Lloyd and Marin (2024) on the interaction with capital controls.

monetary policy cooperation shapes trade wars. Jeanne (2021) analyzes optimal tariffs in a global liquidity trap with and without cooperation. Our paper differs from these studies by characterizing the optimal monetary response to an exogenously given import tariff. Closest to us is Bergin and Corsetti (2023). They study Ramsey optimal *cooperative* monetary policy in a two-country framework and find that, in their calibrated model, the optimal policy is *contractionary* for the tariff-imposing country.[3] To the best of our knowledge, ours is the first analysis of Ramsey-optimal monetary policy chosen *unilaterally* by the tariff-imposing country, and the first to show that the optimal response is expansionary. In addition, our paper articulates why tariff shocks have different implications from those of standard cost-push or terms-of-trade shocks, owing to the fiscal externality associated with the rebated tariff revenue.

Our paper also contributes to a vast literature on optimal monetary policy. In particular, we follow a strand of the literature that focuses on steady-state distortions, such as those arising from monopolistic markups or taxes (see, e.g., Woodford, 2003; Galí, 2015; Afrouzi et al., 2023). A well-known result in the literature is that, in the absence of a production subsidy that offsets firms' market power, optimal monetary policy tolerates nonzero inflation to reduce the labor wedge. Unlike a broad-based consumption or labor tax, a tariff applies only to the foreign consumption good and drives a wedge between the marginal rate of substitution across home and foreign goods and their relative price. This distinction is crucial because, as we show, a tariff does not operate like traditional cost-push shocks: the optimal policy may simultaneously induce inflation and output above the efficient level.

Another related strand of the literature examines optimal monetary policy in multi-sector models. Aoki (2001) considers a two-sector model with sticky prices in one sector and flexible prices in the other, and shows that the optimal policy targets inflation in the sticky-price sector and this delivers the efficient allocation. Woodford (2003) and Benigno (2004) show that in response to asymmetric shocks, the monetary authority faces a tradeoff as it cannot stabilize simultaneously the output gap in all sectors. Rubbo (2023) shows that in response to a sectoral markup shock, optimal policy tolerates positive inflation while driving the *average output gap* negative.[4] By contrast, our model has a single domestic production sector and

[3] Bergin and Corsetti (2023) also find that the optimal policy is expansionary for the *tariff-targeted* country and in a *trade-war* setting. They write "The Ramsey (cooperative) optimal policy redresses the misalignment by prescribing a monetary expansion in the country whose exports are targeted by the foreign trade policy, and a contraction in the country imposing the tariff."

[4] A burgeoning literature has incorporated rich sectoral considerations to understand inflation dynamics and optimal monetary policy (see, e.g., Afrouzi, Bhattarai and Wu, 2024; Baqaee, Farhi and Sangani, 2024; Bernanke and Blanchard, 2023; Bianchi and Coulibaly, 2024; Bianchi, McKay and Mehrotra, 2024; di Giovanni et al., 2022; Fornaro and Romei, 2023; Gagliardone and Gertler, 2023; Guerrieri et al., 2021, 2022; Guerrieri, Lorenzoni and Werning, 2025; La'O and Tahbaz-Salehi, 2022; Rubbo, 2023; Woodford, 2022).

hence no tradeoff among sectoral output gaps. The tariff instead distorts the composition of household consumption between home and foreign goods and creates a fiscal externality that can make it optimal for the central bank to generate simultaneously positive inflation and a positive output gap.

Since our paper was first circulated, a growing literature has emerged on the macroeconomic effects of the Trump administration's unprecedented increase in tariffs. Among these contributions, Monacelli (2025) shows that while temporary export tariffs always reduce employment, import tariffs can either reduce or increase employment depending on the trade elasticity and the monetary regime, Kalemli-Özcan, Soylu and Yildirim (2025) decompose the macroeconomic effects of tariff shocks in a multi-sector model with production networks, Auclert, Rognlie and Straub (2025) study a model with downward wage rigidity, emphasizing the short-run effects of tariffs, and Werning, Lorenzoni and Guerrieri (2025) obtain additional insights into optimal policy in a continuous-time framework with intermediate inputs.[5]

Outline. The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 develops the theoretical results, and Section 4 reports the quantitative findings. Section 5 analyzes extensions of the baseline model. Section 6 concludes. The appendix contains proofs and additional results.

2 Model

We present a small open economy (SOE) model with home-produced and importable goods, subject to nominal rigidities. There is a government in the SOE, which sets an exogenous sequence of tariffs, and a monetary authority, which chooses optimal monetary policy.

2.1 Households

The SOE is populated by a continuum of identical households with preferences given by

$$\sum_{t=0}^{\infty} \beta^t \left[U(c_t) - v(\ell_t) \right],$$

[5] See also Aguiar, Amador and Fitzgerald (2025), Antonova et al. (2025), Benguria and Saffie (2025), Bergin and Corsetti (2025), Caliendo, Kortum and Parro (2025), Dávila et al. (2025), Gopinath and Neiman (2026), Ignatenko et al. (2025), Itskhoki and Mukhin (2025), Jiang et al. (2025), den Besten et al. (2026), Rodríguez-Clare et al. (2025), and Schmitt-Grohé and Uribe (2025).

where

$$U(c_t) = \frac{c_t^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \quad v(\ell_t) = \omega \frac{\ell_t^{1+\psi}}{1+\psi},$$

and c_t is the CES composite of home and foreign consumption goods:

$$c_t = \left[\omega (c_t^h)^{1-\frac{1}{\gamma}} + (1-\omega)(c_t^f)^{1-\frac{1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}.$$

The parameter $\omega \in (0,1)$ represents the preference weight for home goods,[6] $\gamma > 0$ is the elasticity of substitution between home and foreign goods, $\sigma > 0$ is the intertemporal elasticity of substitution, and $\psi > 0$ is the inverse Frisch elasticity of labor supply.

Denote by P_t^h and P_t^f the pre-tariff prices of the home and foreign goods, respectively, both expressed in domestic currency, and let $p = P_t^f / P_t^h$ denote the terms of trade. We assume that p is exogenous, meaning that foreign households view the home good as a perfect substitute for goods produced in other countries. This assumption is appealing because it rules out terms-of-trade manipulation.[7,8] We assume that the law of one price holds for both domestic and foreign goods (pre-tariffs). We assume that both goods have constant prices in foreign currency and, without loss of generality, normalize the foreign-currency price of the home good to one. We let e_t denote the domestic-currency price of foreign currency, so that a higher e_t corresponds to a depreciation of the domestic currency.

Households can trade bonds denominated in either domestic currency or foreign currency. Domestic currency bonds are denoted by B_{t+1} and yield a nominal return R_t, which is set by the monetary authority. Foreign currency bonds are denoted by b_{t+1} and yield a nominal return R^*, which is exogenous to the SOE. Since prices are constant in foreign currency, R^* represents the world real interest rate. The households' budget constraint is given by

$$P_t^h c_t^h + P_t^f (1+\tau_t) c_t^f + \frac{e_t b_{t+1}}{R^*} + \frac{B_{t+1}}{R_t} = e_t b_t + B_t + W_t \ell_t + T_t + D_t,$$

where τ_t denotes the tariff, D_t denotes firms' profits, and T_t corresponds to lump-sum transfers. The household problem is to choose a sequence $\left\{c_t^h, c_t^f, \ell_t, b_{t+1}, B_{t+1}\right\}$ to maximize their utility,

[6] We use the same symbol ω for the weight on home goods in the consumption aggregator and for the level parameter in the disutility of labor. The latter only scales the level of employment, which is a normalization, and this choice simplifies the expressions below.

[7] Following Galí and Monacelli (2005), it is common to assume that each country is a monopolistic producer of a differentiated tradable good, thereby possessing market power over the terms of trade and creating scope for optimal tariffs. In our baseline model, by contrast, the optimal tariff is zero and monetary policy has no effect on the terms of trade. In Section 5.3, we extend the framework to allow for endogenous terms of trade.

[8] Moreover, under this assumption, tariffs fully pass through to import prices at the border, consistent with recent empirical evidence for the U.S. economy (Amiti, Redding and Weinstein, 2019; Fajgelbaum et al., 2020; Cavallo et al., 2021; Gopinath and Neiman, 2026).

subject to their budget constraint and a no-Ponzi-game condition.[9] The first-order conditions yield the following:

$$\frac{W_t}{P_t^h} u_h(c_t^h, c_t^f) = \omega \ell_t^{\psi} \tag{1}$$

$$\frac{1-\omega}{\omega}\left(\frac{c_t^h}{c_t^f}\right)^{\frac{1}{\gamma}} = p(1+\tau_t), \tag{2}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f), \tag{3}$$

$$R_t = R^* \frac{e_{t+1}}{e_t}, \tag{4}$$

where we use $u(c_t^h, c_t^f)$ to denote the utility as a function of the two consumption goods and u_h and u_f to denote the respective partial derivatives.

Condition (1) represents the labor supply decision. Condition (2) determines the optimal split between home goods and foreign goods, by equating the marginal rate of substitution (MRS) to the relative price after tariffs. Condition (3) is an Euler equation that determines savings and the intertemporal path for consumption. Condition (4) is the uncovered interest parity condition (UIP), which equates the expected return on the two bonds expressed in the same currency. We note that given the absence of uncertainty, the gross asset positions of households across currencies are undetermined. For simplicity, we assume henceforth that $B_0 = 0$ to abstract from initial valuation effects arising from monetary policy.

2.2 Firms

There are two types of firms: intermediate and final good producers. Final good producers produce the home good using a CES production function given by:

$$y_t = \left(\int_0^1 y_{jt}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}},$$

where y_{jt} denotes the output of intermediate-good firm j, and ε denotes the elasticity of substitution across varieties. Final good producers are competitive and take as given the price of the home good and the price of inputs. Cost minimization yields the following downward-sloping demand for intermediate inputs: $y_{jt} = \left(\frac{P_{jt}}{P_t^h}\right)^{-\varepsilon} y_t$. In addition, in equilibrium, we must have that $P_t^h = \left(\int P_{jt}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}$.

[9] We use $\{x_t\}$ to refer to the sequence $\{x_t\}_{t=0}^{\infty}$.

Intermediate goods are produced out of labor according to $y_{jt}=\ell_{jt}$. We assume a quadratic cost from changing prices, as in Rotemberg (1982). The problem of an intermediate-good firm is

$$\max_{\{y_{jt},P_{jt}\}} \sum_{t=0}^{\infty} \Lambda_{0,t} \left[(1+s)P_{jt}y_{jt} - W_t y_{jt} - \frac{\varphi}{2}\left(\frac{P_{jt}}{P_{j,t-1}} - 1\right)^2 P_t^h y_t \right], \tag{5}$$

subject to

$$y_{jt} = \left(\frac{P_{jt}}{P_t^h}\right)^{-\varepsilon} y_t,$$

where $\Lambda_{0,t} \equiv \frac{\beta^t u_h(t)}{u_h(0)} \frac{P_0^h}{P_t^h}$ is the nominal discount factor and $s = \frac{1}{\varepsilon - 1}$ is a standard subsidy on production to correct the markup distortion. Using optimality and symmetry ($P_{jt} = P_t^h$ for all j), we obtain the standard dynamic New Keynesian Phillips curve:

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{W_t}{P_t^h} - 1\right] + \beta \frac{u_h(c_{t+1}^h, c_{t+1}^f)}{u_h(c_t^h, c_t^f)} \frac{\ell_{t+1}}{\ell_t} (1+\pi_{t+1})\pi_{t+1}, \tag{6}$$

where $\pi_t \equiv P_t^h / P_{t-1}^h - 1$ represents the inflation rate of home-produced goods, or, equivalently, PPI inflation.

Total firms' net profits transferred to households are given by

$$\frac{D_t}{P_t^h} = (1+s)y_t - \frac{W_t}{P_t^h}\ell_t - \Upsilon \frac{\varphi}{2}\pi_t^2 y_t.$$

We allow for the possibility that only a fraction of the cost of price adjustments results in deadweight losses. Specifically, Υ represents the fraction of price adjustment costs that constitute deadweight losses, while $1-\Upsilon$ is the portion rebated to households. The benchmark case in the New Keynesian model, which will be our quantitative baseline, corresponds to $\Upsilon = 1$.

2.3 Government

The government collects the tariffs and rebates them lump-sum to households (net of the production subsidy). That is, the government budget constraint satisfies

$$\tau_t P_t^f c_t^f = T_t + s\, P_t^h y_t.$$

2.4 Competitive Equilibrium

We are now ready to define a competitive equilibrium.

Definition 1. Given initial bonds b_0, terms of trade p, a government policy $\{\tau_t, s, T_t\}$, and monetary policy $\{R_t\}$, a competitive equilibrium is a set of allocations $\left\{b_{t+1}, \ell_t, c_t^f, c_t^h\right\}$ and prices $\left\{P_t^f, P_t^h, e_t, W_t\right\}$ such that: (i) households maximize their utility; that is, (1)-(4) hold; (ii) firms maximize profits; that is, (6) holds; (iii) labor markets clear; that is, $\ell_t = \int_0^1 \ell_{jt} dj$; and (iv) the government budget constraint holds.

Combining the households' and the government's budget constraints, and the expression for profits, and using the law of one price, we arrive at:

$$\underbrace{\left(1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right)\ell_t - c_t^h}_{\text{exports}} - \underbrace{pc_t^f}_{\text{imports}} = \underbrace{\frac{b_{t+1}}{R^*} - b_t}_{\text{capital outflows}} . \tag{7}$$

This is the standard balance-of-payments condition equating the trade balance to capital outflows.

2.5 Efficient Allocation

We conclude the description of the model with a characterization of the efficient allocation. Given b_0, the planner chooses consumption allocations and bonds to maximize households' welfare:

$$\max_{\left\{b_{t+1}, c_t^f, c_t^h, \ell_t\right\}} \sum_{t=0}^{\infty} \beta^t [u(c_t^h, c_t^f) - v(\ell_t)],$$

subject to

$$c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} = b_t + \ell_t. \tag{8}$$

Optimality implies that

$$\frac{v'(\ell_t)}{u_h(c_t^h, c_t^f)} = 1 \tag{9}$$

$$\frac{1-\omega}{\omega}\left(\frac{c_t^h}{c_t^f}\right)^{\frac{1}{\gamma}} = p, \tag{10}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f). \tag{11}$$

These three conditions indicate that the planner equates (i) the marginal rate of substitution between labor and home consumption to the marginal product of labor (which is 1 unit of home consumption), (ii) the marginal rate of substitution between home and foreign goods to the relative international price, and (iii) the marginal utility of an additional unit of home consumption today to the marginal utility from saving one unit in bonds and consuming it tomorrow.

Comparing the efficient allocation with the competitive equilibrium reveals two distortions introduced by nominal rigidities and tariffs. First, from (1) and (6), nominal rigidities can cause the marginal rate of substitution between home consumption and labor to deviate from the marginal product of labor. Second, comparing (2) and (10) indicates that the tariff distorts the optimal consumption mix between home and foreign goods.

3 Optimal Monetary Policy

In this section, we analytically characterize the optimal monetary policy response to tariffs. We consider the case with government commitment.

3.1 Ramsey Problem

The Ramsey optimal monetary policy consists of choosing the competitive equilibrium that maximizes welfare. We can write the problem as follows:

$$\max_{\{b_{t+1},\pi_t,\ell_t,c_t^f,c_t^h\}} \sum_{t=0}^{\infty} \beta^t \left[u(c_t^h, c_t^f) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right], \tag{12}$$

subject to

$$c_t^h + p c_t^f + \frac{b_{t+1}}{R^*} = b_t + \left[1 - \Upsilon \frac{\varphi}{2} \pi_t^2 \right] \ell_t, \tag{13}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi} \left[\frac{\omega\, \ell_t^{\psi}}{u_h(c_t^h, c_t^f)} - 1 \right] + \frac{1}{R^*} \frac{\ell_{t+1}}{\ell_t} (1+\pi_{t+1})\pi_{t+1}, \tag{14}$$

$$\frac{1-\omega}{\omega} \left(\frac{c_t^h}{c_t^f} \right)^{\frac{1}{\gamma}} = p(1+\tau_t), \tag{15}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f). \tag{16}$$

Before we analyze the optimal policy problem, we examine a benchmark where the

monetary authority fully stabilizes PPI inflation, i.e., $\pi_t = 0$. That is, the central bank lets the CPI price level undergo a one-time jump in response to tariffs, followed by the stabilization of inflation thereafter. In line with policy discussions (see Waller, 2025b), we refer to this policy as look-through.

Definition 2 (Look-through policy)**.** A look-through policy keeps $\pi_t = 0$ for all t.

A common result in the literature is that targeting PPI inflation is optimal under a variety of shocks in standard open economy New Keynesian models (see, e.g., Clarida, Galí and Gertler, 2002; Galí and Monacelli, 2005). Consistent with this, our first result shows that in the absence of tariffs, a look-through policy delivers the efficient allocation—that is, divine coincidence holds.

Proposition 1 (Efficiency)**.** *If $\tau_t = 0$ for all t, the solution to the Ramsey problem (12) coincides with the efficient allocation. Moreover, the look-through policy implements the efficient allocation.*

Proof. Setting $\tau_t = 0$ and $\pi_t = 0$ in the implementability constraints (13)-(16), we arrive at the conditions characterizing the efficient allocation, (8)-(11). □

In the presence of positive tariffs, however, the efficient allocation is no longer feasible. Setting $\pi_t = 0$ for all t, we see that the three conditions in the planner's problem—(8), (9), and (11)—are satisfied, but comparing (10) and (15) indicates that the ratio of home to foreign consumption is too high relative to what the planner would choose under *any* monetary policy. This tension highlights why, once tariffs are introduced, the monetary authority has incentives to depart from strict PPI targeting and pursue an alternative policy response.

The next section derives the optimal policy response.

3.2 Analytical Benchmark ($\Upsilon = 0$)

In this section, we consider the case where price adjustment costs are rebated to households (i.e., $\Upsilon = 0$). Note that although inflation does not generate resource losses, it still affects firms' employment decisions and, consequently, the labor wedge. As we will see, this assumption allows us to reformulate the problem and obtain closed-form solutions.

In addition, we make the following assumptions:

Assumption 1. *The parameter values are such that $\beta R^* = 1$, $\tau_t = \tau \geq 0$, $b_0 = 0$.*

These assumptions imply that the path of consumption is constant for any (constant) level of tariffs. Moreover, under the natural allocation, the trade balance is zero for all t.

Note that in the optimal policy problem (12), with $\Upsilon = 0$ we have that π_t appears only in the Phillips curve, and thus we can drop constraint (14) as an implementability constraint and the Ramsey problem is time-consistent. Moreover, constant tariffs and $\beta R^* = 1$ imply that home and foreign consumption are constant and $\psi > 0$ implies that labor is constant.

We can therefore reduce the monetary authority's problem to a static maximization problem where the planner chooses labor and consumption subject to the resource constraint and a relative price-MRS constraint:

$$\max_{c^h, c^f, \ell} \; u(c^h, c^f) - \omega \frac{\ell^{1+\psi}}{1+\psi} \tag{17}$$

$$\text{subject to}$$

$$c^h + p c^f = \ell,$$

$$\frac{1-\omega}{\omega} \left(\frac{c^h}{c^f} \right)^{\frac{1}{\gamma}} = p(1+\tau),$$

This formulation highlights that, when price adjustment costs are rebated, optimal monetary policy can be reformulated as the *problem of a planner choosing labor on behalf of households, while households determine the mix of the two consumption goods.*

The proposition below establishes that the level of employment is higher under optimal policy than under look-through, strictly so whenever tariffs are positive.

Proposition 2 (Macroeconomic effects of tariffs)**.** *Suppose that Assumption 1 holds and that* $\Upsilon = 0$*. Then, the levels of employment under the look-through policy and under the optimal policy are given, respectively, by*

$$\ell_t^{look}(\tau) = \left[\frac{\Theta_\tau + \tau}{1+\tau} \left(\omega \Theta_\tau \right)^{\frac{\sigma-\gamma}{\gamma-1}} \right]^{\frac{1}{1+\sigma\psi}}, \tag{18}$$

$$\ell_t^{opt}(\tau) = \left(\frac{1+\tau}{1+\Theta_\tau^{-1}\tau} \right)^{\frac{\sigma}{1+\sigma\psi}} \left[\frac{\Theta_\tau + \tau}{1+\tau} \left(\omega \Theta_\tau \right)^{\frac{\sigma-\gamma}{\gamma-1}} \right]^{\frac{1}{1+\sigma\psi}} \geq \ell_t^{look}(\tau), \tag{19}$$

where we define $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma} \left(p(1+\tau)\right)^{1-\gamma} > 1$*. The inequality in* (19) *is strict whenever* $\tau > 0$*.*

In addition, the levels of consumption are given by

$$c_t^{h,j}(\tau) = \frac{1+\tau}{\Theta_\tau + \tau}\ell_t^j(\tau), \qquad c_t^{f,j}(\tau) = \frac{\Theta_\tau - 1}{p\left(\Theta_\tau + \tau\right)}\ell_t^j(\tau), \quad \textit{for } j \in \{look, opt\}$$

and the constant level of inflation consistent with the optimal allocation is positive.

The monetary authority internalizes that when households work more, they demand more imports and raise tariff revenue, thereby raising aggregate income for all households. Because tariffs inefficiently depress imports, the monetary authority overheats the economy to mitigate this decline.[10] The proposition also implies that the optimal policy induces a positive level of inflation. Since employment under the optimal policy exceeds the level associated with the zero-inflation allocation, sustaining this higher level of employment requires positive inflation to stimulate the economy.

How do tariffs affect employment?

We analyze how tariffs affect employment under the two monetary policy regimes by differentiating the employment function in Proposition 2 with respect to τ.

Look-through policy. We first consider the response of employment under a look-through policy. This case is a useful benchmark, since look-through implements the flexible-price allocation, which in the absence of tariffs coincides with the efficient allocation. The corollary below characterizes the response of employment to tariffs:

Corollary 1 (Employment response under look-through)**.** *Under the look-through policy, the effect of tariffs on employment is given by*

$$\frac{d\log \ell^{look}}{d\tau} = -\frac{(\Theta_\tau - 1)}{(1+\sigma\psi)(1+\tau)(\Theta_\tau + \tau)\Theta_\tau}\left[\sigma\Theta_\tau + (\sigma - \gamma)\tau\right]. \tag{20}$$

The key takeaway is that tariffs may be contractionary or expansionary under look-through. The first term in (20) is negative, but the bracketed term has an ambiguous sign. As a result, depending on parameter values, higher tariffs may reduce or increase employment.

The result that tariffs can be expansionary in our setup is perhaps surprising. In a canonical one-sector model, a consumption tax is equivalent to a tax on labor supply—it

[10] Given the utility function we consider with the CES-CRRA structure, preferences are homothetic in our setup. We expect our results to hold generally for any preferences where both home and foreign goods are normal.

lowers the real consumption wage (a substitution effect) and a lump-sum rebate of the tax raises income (a wealth effect)—so both forces reduce employment. One might therefore expect tariffs on imported consumption goods to necessarily reduce employment. That logic does not carry over here because the tax applies only to foreign consumption goods.

The ambiguity arises because tariffs alter two relative prices: (i) the relative price of foreign versus home goods and (ii) the relative price of foreign goods versus labor. These shifts generate two distinct effects on labor supply. First, a tariff reduces the real wage measured in foreign goods, discouraging work. Second, the induced change in the consumption mix raises or lowers the marginal utility of home goods, depending on the sign of $\sigma - \gamma$. When $\sigma > \gamma$, so that $u_{hf} > 0$ and the two goods are Edgeworth complements, a fall in foreign consumption lowers the marginal utility of home goods, inducing households to work less. Conversely, when $\sigma < \gamma$, so that $u_{hf} < 0$ and the two goods are Edgeworth substitutes, a fall in foreign consumption raises the marginal utility of home goods, inducing households to work more.

Evaluating (20) at $\tau = 0$ shows that a marginal increase in tariffs always reduces employment under look-through. The logic is that, starting from the efficient allocation, the shift in expenditures toward home goods lowers the marginal utility of home consumption, which translates directly into lower employment. By contrast, when the two goods are Edgeworth substitutes, sufficiently large tariffs can raise employment.[11] Intuitively, the contractionary force operates through the real wage measured in foreign goods and therefore matters less the smaller the share of imports in the consumption basket. As tariffs rise, the import share shrinks and that force fades, while lower imports continue to raise the marginal utility of home goods at any given level of employment. Beyond a threshold tariff, the latter dominates and employment expands.

These results connect to an early debate—dating back to Keynes (1937) and Mundell (1961)—over whether tariffs are expansionary or contractionary for output. In particular, Mundell (1961) emphasizes contractionary effects under flexible exchange rates. In his static framework, the contraction arises from an exchange-rate appreciation and higher saving via the Harberger–Laursen–Metzler mechanism (Harberger, 1950; Laursen and Metzler, 1950). Here, by contrast, the contraction operates through a labor-supply channel and arises even in the absence of movements in the exchange rate or the terms of trade.[12]

[11] As will become clear below, a further necessary condition for employment under the look-through policy to exceed its no-tariff level is $\sigma < 1$.

[12] Barattieri et al. (2021) likewise find that tariffs are contractionary in quantitative simulations but—distinct from the mechanism we highlight—attribute the downturn to a contractionary monetary-policy response and a decline in real aggregate income.

Optimal policy. Let us turn now to the response of employment under the optimal policy. Following Proposition 2, the corollary below summarizes the result:

Corollary 2 (Employment response under optimal policy)**.** *Under optimal monetary policy, the effect of tariffs on employment is given by*

$$\frac{d\log \ell^{opt}}{d\tau} = \frac{(\Theta_\tau - 1)}{(1+\sigma\psi)(1+\tau)(\Theta_\tau+\tau)\Theta_\tau}(1-\sigma)\gamma\tau.$$

Starting from zero tariffs, a marginal tariff increase leaves employment unchanged: the monetary authority shifts expenditure from foreign to home goods while keeping employment fixed. At strictly positive tariffs, the sign of the employment response depends solely on the intertemporal elasticity of substitution. When $\sigma > 1$, employment falls, reflecting a stronger substitution effect; when $\sigma < 1$, employment rises, reflecting a stronger income effect. When $\sigma = 1$, employment is independent of tariffs and there is only consumption substitution toward home goods. Figure 1 illustrates these results for the optimal policy (blue solid line) alongside the look-through policy (red dashed line).

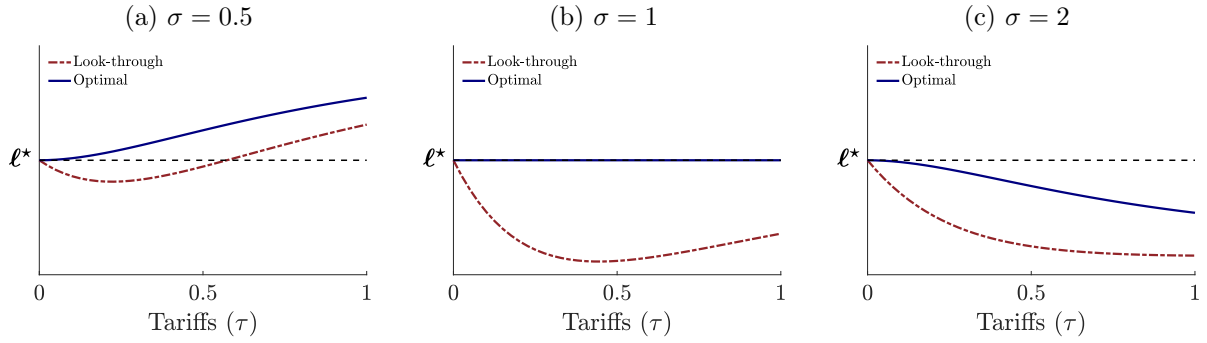


Figure 1: Employment as a function of tariffs.

Notes: Parameters: $\gamma = 4$, $\omega = 0.5$ and $\psi = 0$. The black dashed line represents the efficient level of employment.

Three lessons thus emerge from the analysis. First, divine coincidence does not hold in the presence of tariffs. While PPI inflation targeting implements the natural level of output, that level does not coincide with the efficient one. Second, output under optimal policy exceeds output under the look-through policy. Third, output may lie below or above the efficient level depending on σ.

3.3 Inspecting the Mechanism

In this section, we isolate the fiscal externality that lies behind the expansionary response.

The fiscal externality. Let us define an "indirect utility function" as

$$\mathcal{W}(c^f;\tau) \equiv u\Big(\boldsymbol{L}\left(c^f\right) + \boldsymbol{T}\left(c^f\right) - p(1+\tau)c^f, c^f\Big) - \frac{\omega}{1+\psi}\Big(\boldsymbol{L}\left(c^f\right)\Big)^{1+\psi}$$

and denote by $\boldsymbol{T}(c^f)=p\tau c^f$ and $\boldsymbol{L}(c^f)=\frac{\Theta_\tau+\tau}{\Theta_\tau-1}p\,c^f$ the levels of tariff revenue and employment consistent in equilibrium with a level of c^f for any τ. In this formulation, the monetary authority's problem can be reduced to choosing c^f subject to the implementability constraints.

The optimal level of imports c^f, given τ, maximizes $\mathcal{W}$, in which (15) has already been used to construct $\boldsymbol{L}$ and $\boldsymbol{T}$. The first-order condition yields

$$0 = \frac{\partial \boldsymbol{L}}{\partial c^f}\underbrace{\left[1 - \frac{\omega \ell^\psi}{u_h(c^h, c^f)}\right]}_{\text{labor wedge}} + \underbrace{\frac{\partial \boldsymbol{T}}{\partial c^f}}_{\text{fiscal externality}} .$$

The second term on the right-hand side captures the fiscal externality, as households do not internalize that by consuming more imports, they raise the fiscal transfer received by other households. The fact that $\frac{\partial \boldsymbol{L}}{\partial c^f} > 0$ then implies that the monetary authority finds it optimal to stimulate employment and, thereby, raise imports.

The key idea is that tariffs lead households to undervalue the consumption of imported goods. Households perceive imports as more expensive relative to the social cost because they fail to internalize that when they increase import expenditures, this raises fiscal revenues and aggregate income. To mitigate this fiscal externality, the optimal policy is to overheat the economy.[13]

3.4 Comparison with Other Shocks

This section contrasts tariffs with three familiar shocks—terms-of-trade shocks, textbook cost-push shocks, and sectoral markup shocks—and shows how the fiscal externality changes the standard policy prescription in each case.

[13]We note that the same fiscal externality would emerge if the government were to use the tariff revenue to pay down public debt or to spend on a public good. In the latter case, households fail to internalize that higher imports would increase the funding for the public good.

Tariffs versus terms-of-trade shocks: The role of fiscal revenue. Consider a scenario in which tariffs are introduced and the revenue "is thrown into the ocean." In this case, the monetary authority's problem in (12) faces the following intertemporal budget constraint

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c_t^h + p(1+\tau_t) c_t^f - \left(1 - \Upsilon \frac{\varphi}{2} \pi_t^2\right) \ell_t \right] \tag{21}$$

An important observation is that this budget constraint is identical to the one that arises in a situation where a TOT shock changes the international price of imports to $p(1+\tau)$. It follows from (21) that *a tariff whose revenue is not rebated is equivalent to a TOT shock.* The proposition below shows that in this case targeting PPI inflation is optimal.

Proposition 3 (Optimal policy absent fiscal rebate)**.** *Suppose that tariff revenues are not rebated. Then, the central bank finds it optimal to implement an allocation with zero inflation. Moreover, under Assumption 1, the levels of employment and consumption are, respectively, given by*

$$\ell_t^\diamond(\tau) = \left[\Theta_\tau \left(\omega \Theta_\tau \right)^{\frac{\sigma-\gamma}{\gamma-1}} \right]^{\frac{1}{1+\sigma\psi}}, \quad c_t^h(\tau) = \frac{1}{\Theta_\tau} \ell_t^\diamond(\tau), \quad c_t^f(\tau) = \frac{\Theta_\tau - 1}{p(1+\tau)\Theta_\tau} \ell_t^\diamond(\tau), \tag{22}$$

and $\pi_t = 0$. Moreover, a change in tariffs has the same effects as a change in p.

At the level of an individual household, an increase in the price of foreign goods has identical implications whether it reflects a change in the terms of trade or tariffs. In the aggregate, however, the consequences differ. When the tariff revenue is rebated, households do not internalize that higher imports raise aggregate transfers. It is this fiscal externality that leads the monetary authority to deviate from targeting PPI inflation and overheat the economy. On the other hand, if tariff revenue is thrown into the ocean, the monetary authority does not find it optimal to deviate from the flexible-price allocation. Figure E.1 in the appendix illustrates this contrast in the calibrated model, comparing the optimal response to a tariff with the optimal response to a terms-of-trade shock of the same magnitude.

Comparing (22) with Proposition 2 shows that

$$\ell_t^\diamond(\tau) = \left(\frac{1 + \Theta_\tau^{-1} \tau}{1+\tau} \right)^{\frac{\sigma-1}{1+\sigma\psi}} \ell_t^{opt}(\tau) > \ell_t^{look}(\tau).$$

That is, employment is higher when tariff revenue is not rebated. Because tariff revenue creates a wealth effect that raises non-labor income, it reduces labor supply. Under optimal policy, however, the ranking is ambiguous: monetary expansion raises employment, while the

rebate's wealth effect lowers it.

Tariffs versus textbook cost-push shocks. Like cost-push shocks, tariffs break divine coincidence by driving a wedge between the flexible-price allocation and the efficient allocation. The textbook response by the central bank to cost-push shocks involves positive inflation and a positive output gap as a way to mitigate the fall in output. Whereas the textbook response implies that output remains below the efficient level, Proposition 2 shows that when $\sigma < 1$, the central bank chooses to stimulate output so that it rises *above its efficient level*. The difference from the textbook case is the fiscal externality: by raising employment and aggregate income, policy boosts import demand and tariff revenue, partially undoing the inefficient contraction in imports.[14]

Tariffs versus multi-sector markup shocks. It is also useful to contrast tariffs with sectoral markup shocks. In a multi-sector New Keynesian model, an asymmetric markup shock creates conflicting stabilization objectives across sectors: the central bank cannot simultaneously stabilize all sectoral inflation rates and close all sectoral output gaps. Optimal policy therefore trades off a weighted average of sectoral inflation rates against a weighted average of sectoral output gaps. As Rubbo (2023) shows, following an adverse sectoral markup shock, the central bank tolerates positive CPI inflation while pushing the *average output gap* below zero.[15] Our model has a single domestic production sector, so there is no conflict among sectoral output gaps. Instead, the tariff distorts the composition of household consumption between home and foreign goods and, because tariff revenue is rebated, creates a fiscal externality that leaves imports inefficiently low, calling for a monetary expansion that can push output above the efficient level.

[14] Werning, Lorenzoni and Guerrieri (2025) study a continuous-time model with intermediate inputs and show that, under balanced trade and $\sigma = 1$, the central bank stimulates the economy but holds output below its efficient level, as in the textbook cost-push case. They also derive a welfare loss function for tariff shocks in which the central bank places positive weight on inflation, the output gap, and deviations of imports from their efficient level. That third term is absent from the textbook cost-push objective, and it is precisely the fiscal externality at work. When $\sigma = 1$, the incentive to push output above its efficient level vanishes. For $\sigma < 1$, by contrast, the incentive remains: as panel (a) of Figure 1 and Corollary 2 show, the central bank finds it optimal to stimulate the economy further even at the tariff level where zero inflation would already deliver efficient output.

[15] Rubbo (2023) shows that the optimal targeting rule in a multi-sector New Keynesian model takes the form $\tilde{y}_t + B^\top L \pi_t = 0$, where π_t is the vector of sectoral inflation rates, B is the vector of sectoral Phillips-curve slopes, L is the welfare-weighting matrix on sectoral inflation, and $\tilde{y}_t$ is the log deviation of aggregate output from its flexible-price level. See also Afrouzi et al. (2024) for a related result.

3.5 General Case with Inflation Costs ($\Upsilon > 0$)

A simplifying assumption in the previous section is that changing prices is privately costly for firms but does not entail any resource costs. The optimal monetary policy becomes more complex when $\Upsilon > 0$, particularly because the Ramsey planner now faces the Phillips curve as an implementability constraint. Nevertheless, as we will see, the optimal stance remains expansionary.[16]

Let us set $\Upsilon = 1$ and maintain the assumptions that $\beta R^* = 1$ and $\tau_t = \tau$. Under these assumptions, we have that (15) and (16) imply that c_t^f and c_t^h are still constant. Iterating forward on the country budget constraint (7), we can write the problem as

$$\max_{\{c^h, c^f, \ell_t, \pi_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c^h, c^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right],$$

subject to

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c^h + p c^f - \left(1 - \frac{\varphi}{2}\pi_t^2\right) \ell_t \right], \qquad [\lambda] \qquad (23)$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega \ell_t^{\psi}}{u_h(c^h, c^f)} - 1 \right] + \beta \frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \qquad [\eta_t] \qquad (24)$$

$$c^f \leq \left[\frac{1-\omega}{\omega p (1+\tau)} \right]^{\gamma} c^h, \qquad [\xi] \qquad (25)$$

with Lagrange multipliers in brackets. While the implementability constraint (25) holds with equality at the optimum, we express it as an inequality to make explicit the direction in which the constraint binds for $\tau > 0$. In addition, we express the Lagrangian so that a higher η_t reflects a positive marginal gain from lowering the left-hand side of (24) (i.e., reducing π_t in period t).

Optimality with respect to c^h yields

$$u_h(c^h, c^f) + \frac{c^f}{c^h}\xi = \lambda + \frac{\gamma + \sigma(\Theta_\tau - 1)}{\gamma \sigma \Theta_\tau} \frac{\varepsilon}{\varphi} \sum_{t=0}^{\infty} (1-\beta)\beta^t \frac{\omega \ell_t^{\psi}}{c^h u_h(c^h, c^f)} \eta_t. \qquad (26)$$

Condition (26) equates the marginal utility benefits from consumption to the marginal costs. The benefits are given by the sum of the direct utility from one extra unit of home consumption plus the gains from relaxing the implementability constraint (25). That is,

[16] Note that Υ does not play a role under look-through policy since $\pi_t = 0$ and hence there are no inflation costs.

since the relative price-MRS constraint effectively imposes a lower bound on c^h/c^f, a rise in c^h helps relax the constraint. The costs are given by the shadow value of resources plus the present discounted value of the inflationary cost captured by the marginal effect on the Phillips curve constraint (24).

Optimality with respect to c^f yields:

$$u_f(c^h, c^f) - \xi = \lambda p - \frac{(\sigma - \gamma)(\Theta_\tau - 1)}{\gamma\sigma\Theta_\tau} \frac{\varepsilon}{\varphi} \sum_{t=0}^{\infty} (1-\beta)\beta^t \frac{\omega \ell_t^\psi}{c^f u_h(c^h, c^f)} \eta_t. \tag{27}$$

Relative to the previous first-order condition, we can see now that an increase in c^f tightens (25). Combining (26) and (27), we obtain

$$\xi = \frac{p\,(1+\tau)}{\Theta_\tau + \tau} \left[\tau + \frac{\gamma + \sigma(\Theta_\tau - 1)}{\gamma\sigma\Theta_\tau} \frac{\varepsilon}{\varphi} \sum_{t=0}^{\infty} (1-\beta)\beta^t \frac{\omega \ell_t^\psi}{c^h u_h\left(c^h, c^f\right)} \eta_t \right].$$

This expression indicates that a higher tariff, and thus a higher Lagrange multiplier on the relative price-MRS constraint (25), will be associated with a higher Lagrange multiplier on the Phillips curve constraint (in present discounted terms).

The first-order condition with respect to $\{\ell_t\}$ yields

$$\omega \ell_t^\psi + \frac{\varepsilon}{\varphi} \left[(\psi + 1) \frac{\omega \ell_t^\psi}{u_h(c^h, c^f)} - 1 \right] \frac{\eta_t}{\ell_t} + (1 + \pi_t)\pi_t \left(\frac{\eta_{t-1}}{\ell_{t-1}} - \frac{\eta_t}{\ell_t} \right) = \left(1 - \frac{\varphi}{2} \pi_t^2 \right) \lambda, \tag{28}$$

which equates the marginal cost of one more unit of labor (including the marginal effect on current and future Phillips curve constraints) to the marginal value of the additional resources. Finally, we have the following first-order condition with respect to $\{\pi_t\}$:

$$\frac{\pi_t}{1 + 2\pi_t} = \frac{1}{\varphi\lambda} \left(\frac{\eta_t}{\ell_t} - \frac{\eta_{t-1}}{\ell_{t-1}} \right), \quad \text{for } t > 0, \tag{29}$$

while at $t = 0$, the condition simplifies to

$$\frac{\pi_0}{1 + 2\pi_0} = \frac{\eta_0}{\varphi\lambda\ell_0}. \tag{30}$$

The difference between the $t = 0$ and $t > 0$ optimality conditions reflects the fact that the monetary authority perceives a higher cost from future inflation. This is because, through the forward-looking Phillips curve, higher inflation in the future leads to higher inflation today.

We note that $1 + 2\pi_0 > 0$.[17] Condition (30) then implies that π_0 and η_0 have the same sign. Intuitively, when inflation is positive, the monetary authority recognizes that relaxing the Phillips curve (by allowing for lower inflation) would strictly improve welfare by reducing inflation costs and increasing available resources.

The next proposition shows that, as in the case with $\Upsilon = 0$, the optimal monetary policy overheats the economy in the sense that it induces a negative labor wedge, defined as $\wp_t \equiv 1 - \frac{\omega \ell_t^{\psi}}{u_h(c_t^h, c_t^f)}$.

Proposition 4 (Optimal policy with inflation costs ($\Upsilon > 0$))**.** *Suppose that Assumption 1 holds with $\tau > 0$, that $\Upsilon = 1$, and that $\psi \to 0^+$. Then, under optimal monetary policy, the labor wedge is given, to a first-order approximation around the zero-inflation allocation, by*

$$\wp_t \approx -\tau \frac{\Theta_\tau - 1}{\Theta_\tau + \tau} < 0.$$

That is, the optimal monetary policy is expansionary.

Starting from an allocation with zero inflation and a zero output gap, stimulating the economy does not entail a first-order loss, while the induced increase in imports generates strictly positive first-order gains. This makes overheating a desirable outcome for the monetary authority. Notice that, unlike the case without inflation costs, the monetary authority implements a decreasing path for inflation. The intuition is that higher future inflation feeds into current inflation through the forward-looking Phillips curve, thereby increasing current resource costs.[18]

The main takeaway is that the optimal monetary policy calls for overheating the economy, raising employment and inflation above and beyond the look-through policy. In the next section, we calibrate the model and quantitatively assess the macroeconomic effects of tariffs and the normative implications for monetary policy.

[17] The argument for why $1 + 2\pi_0 > 0$ is as follows. We observe that $\pi_0(1 + \pi_0)$ has a minimum at $\pi_0 = -0.5$. Moreover, for any $\pi_0 < -0.5$, we can find $\pi_0' \in (-0.5, 0)$ such that the Phillips curve holds and we have the same ℓ and higher c^f and c^h. Thus, any allocation with $\pi_0 < -0.5$ is dominated.

[18] Note that the wedge in Proposition 4 is in fact the same one that arises without inflation costs. Combining the first-order conditions for c^h and ℓ in the benchmark of Section 3.2 gives $\omega \ell^{\psi} / u_h(c^h, c^f) = \Theta_\tau(1+\tau)/(\Theta_\tau + \tau)$, so that $\wp = -\tau(\Theta_\tau - 1)/(\Theta_\tau + \tau)$ holds exactly when $\Upsilon = 0$, for any ψ. The resource cost of inflation is second order around $\pi_t = 0$ and therefore does not enter the condition that determines the wedge: it shapes the path of inflation, not the extent of overheating.

4 Quantitative Analysis

4.1 Calibration

We calibrate the model to the U.S. economy at a quarterly frequency and solve it using a global nonlinear algorithm.[19] Table 1 presents the values for the parameters.

The discount factor is set to $\beta = 0.99$, which implies an annual risk-free rate of 4%, given that $R^* = 1/\beta$. We set the Frisch elasticity of labor supply and the intertemporal elasticity of substitution to standard values, $1/\psi = 1$ and $\sigma = 1/2$, respectively. As in Galí and Monacelli (2005), we set the elasticity of substitution between differentiated varieties to $\varepsilon = 6$, which implies a price markup of 20%. We normalize the relative price of foreign goods to $p = 1$ and set $\omega = 0.45$. Under the CES aggregator, this implies a ratio of imports to tradable GDP in the model of approximately $1/(1 + (\omega/(1-\omega))^{\gamma})$, consistent with an import share of total GDP of 14% and a tradables share of GDP of about one-fifth in U.S. data.

Table 1: Calibration

Parameter	Description	Value
β	Discount factor	0.99
γ	Elasticity between h and f	4
σ	Intertemporal elasticity	0.5
ψ	Inverse Frisch elasticity	1
ω	Preference weight	0.45
ε	Elasticity of substitution (varieties)	6
φ	Price-adjustment cost	3,272

The two remaining parameters are the price adjustment cost, φ, and the elasticity of substitution between home and foreign goods, γ. These parameters are crucial because they determine, respectively, the effectiveness of monetary policy and the welfare effects of tariffs. We calibrate φ so that the slope of the linearized Phillips curve equals 0.005, following the estimate from Hazell et al. (2022). We set γ equal to 4, which lies within the empirical range (see Boehm, Levchenko and Pandalai-Nayar, 2023; Caliendo and Parro, 2022).

[19] We solve for the sequence of allocations, prices, and policies by using a Newton method that iterates on the set of nonlinear difference equations that characterize the Ramsey problem for a given initial level of b_0.

4.2 Baseline Results

We assume throughout that the economy is initially at a steady state where $b_0 = 0$ and that there are no tariffs. We first study the optimal response to a permanent increase in tariffs.[20] For each experiment, we will present the simulation path for the relevant macroeconomic variables. We report annualized home-good inflation and the trade balance as a share of GDP. Aggregate consumption (measured as consumption of the composite good), employment, the consumer price level, and the exchange rate are expressed as percentage deviations from the pre-tariff allocation. We denote the (tradable) consumer price level as $\mathcal{P}_t^c = P_t^h \left(\omega^\gamma + (1-\omega)^\gamma (p(1+\tau_t))^{1-\gamma}\right)^{\frac{1}{1-\gamma}}$.

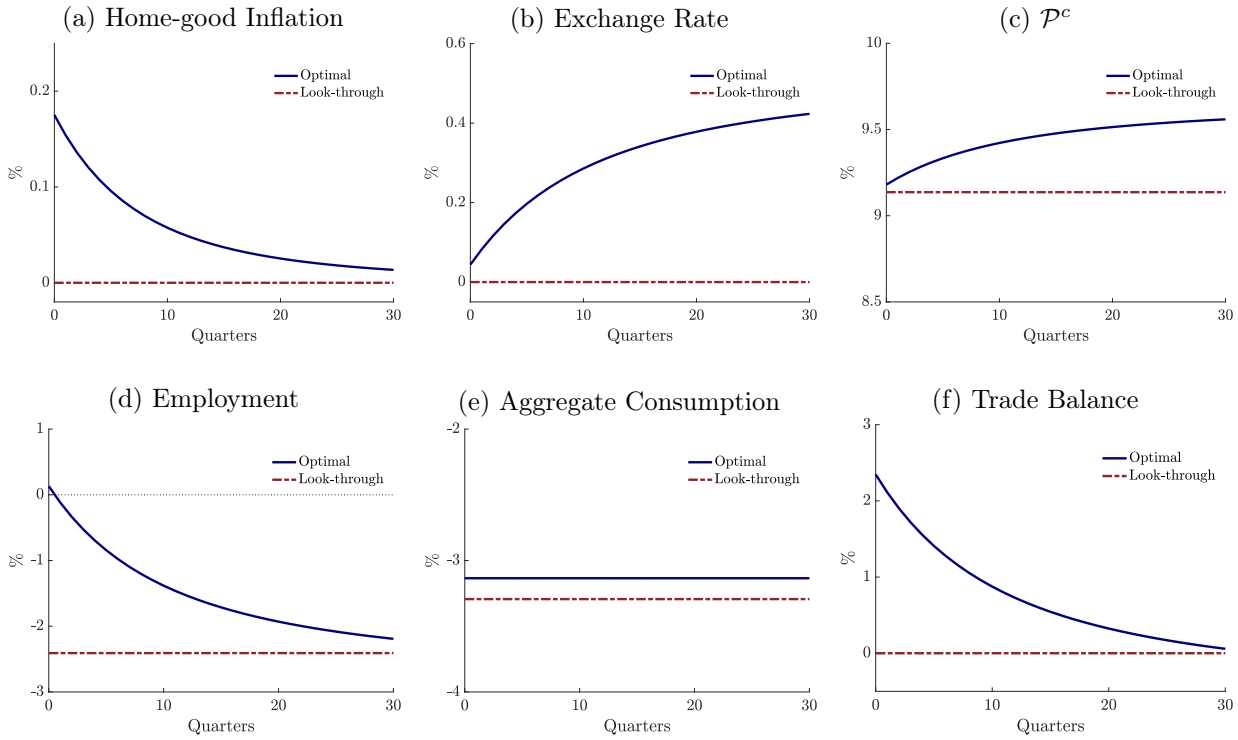


Figure 2: Baseline response to a permanent tariff

Notes: The tariff is set to $\tau_t = 15\%$ for all t. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure 2 presents the simulations in response to a permanent tariff of $\tau = 15\%$, in line with recent tariff measures of the Trump administration. We compare the optimal policy

[20] Note that because the initial steady state is efficient, the notion of optimal policy from a "timeless perspective" is immaterial. In Section 5.2, we examine a case where the initial steady state is inefficient and this distinction matters.

(blue solid line) with the "look-through" policy (red dashed line). Recall that the look-through policy stabilizes inflation for home-produced goods (i.e., $\pi_t = 0$) while allowing the CPI to jump following the one-time increase in import prices (panels a and c). As the figure illustrates, under look-through, the exchange rate and the trade balance remain constant at their pre-tariff levels (panels b and f). Moreover, employment declines (panel d) because, as discussed in Section 3.2, tariffs tend to depress labor supply. Finally, aggregate consumption is permanently lower (panel e), consistent with the contractionary effect of tariffs.

Under the optimal policy, employment rises modestly on impact and then declines, but by substantially less than under the look-through policy. Moreover, inflation and the exchange rate increase in the short run (panels a and b) as the monetary authority stimulates the economy. Over time, inflation declines and converges to zero. The long-run allocation coincides with the flexible-price allocation, characterized by zero inflation (panel a). The monetary stimulus generates a trade surplus that accumulates into a higher net foreign asset (NFA) position. The implication that a permanent tariff raises the trade surplus contrasts with standard neutrality results (Razin and Svensson, 1983).[21] The mechanism is that monetary stimulus induces higher saving, and hence a larger trade balance.

4.3 Temporary Tariffs

We now consider a temporary shock to tariffs. In particular, we assume that tariffs follow an autoregressive process $\tau_t = \rho\tau_{t-1}$, with $\tau_0 = 15\%$ and $\rho = 0.976$, so that the half-life of the shock is 7 years. Figure E.2 presents the results.

When tariffs are temporary, households anticipate that the cost of consuming imported goods will decline in the future, increasing the marginal benefit of saving to shift consumption toward the future. As a result, a trade surplus emerges under the look-through policy, while the surplus is even larger under the optimal policy. It is useful to note that the economy does not return to its initial allocation in the long run, even if the shock is temporary. This occurs because, in an incomplete-markets model, a temporary shock has permanent effects on the NFA position, resulting in different long-run allocations. A key takeaway is that, as in the case of a permanent tariff, the monetary authority lets the exchange rate depreciate to stimulate the economy.

[21] Recent work highlights additional mechanisms through which permanent tariffs can reduce trade deficits. See Aguiar, Amador and Fitzgerald (2025); Itskhoki and Mukhin (2025) for valuation effects and Costinot and Werning (2025) for convex Engel curves.

4.4 Shock to Future Tariffs

We study the effects of an announced tariff. A tariff is announced at date 0, implemented at date 4, and then held constant. Figure E.3 presents the results of this simulation. The tariff announcement leads to a trade deficit and a decrease in the NFA position, as agents increase their consumption of foreign goods before the price hike occurs. We show that the anticipation of tariffs generates a more delicate tradeoff for the monetary authority. As before, stimulating the economy at $t = 0$ helps to raise aggregate income and overall consumption. However, we also now have an inefficient increase in imports before the tariff hike takes place. As a result, the monetary authority implements an expansionary monetary policy, although less expansionary than under an unanticipated tariff.[22]

5 Extensions and Further Analysis

5.1 Intermediate Inputs

Our baseline model considers only imports of final consumption goods. We now extend the analysis to allow for imported intermediate inputs. We assume that the production of domestic intermediate goods requires inputs imported from abroad in addition to labor. In particular, gross output is given by $y_{jt} = \ell_{jt}^{1-\nu}(x_{jt}^f)^\nu$, and the country's budget constraint becomes

$$c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} = b_t + \left(1 - \Upsilon\frac{\varphi}{2}\pi_t^2\right) y_t - p\, x_t^f, \tag{31}$$

where the last term on the right-hand side represents the cost of imported intermediate inputs.

In addition to distorting households' consumption bundle, tariffs also raise the relative price of imported intermediate inputs and distort firms' factor mix between labor and inputs (see Appendix B). Mirroring our baseline model, tariffs induce firms to perceive an inefficiently high cost of imports, which the monetary authority counteracts by stimulating the economy.[23]

Figure 3 presents the results of a permanent tariff that applies to both consumption goods and inputs.[24] We calibrate the output elasticity with respect to imported inputs to match the fact that half of imports are intermediate inputs, which yields $\nu = 0.35$; we recalibrate ω to continue matching the import share. Under the look-through policy, GDP (defined as

[22] Figure E.4 shows that as implementation is delayed, the monetary stimulus becomes weaker.
[23] See Appendix B.2 for analytical derivations under $\Upsilon = 0$.
[24] Figures B.1 and B.2 present cases where tariffs apply only to consumption goods or intermediate inputs.

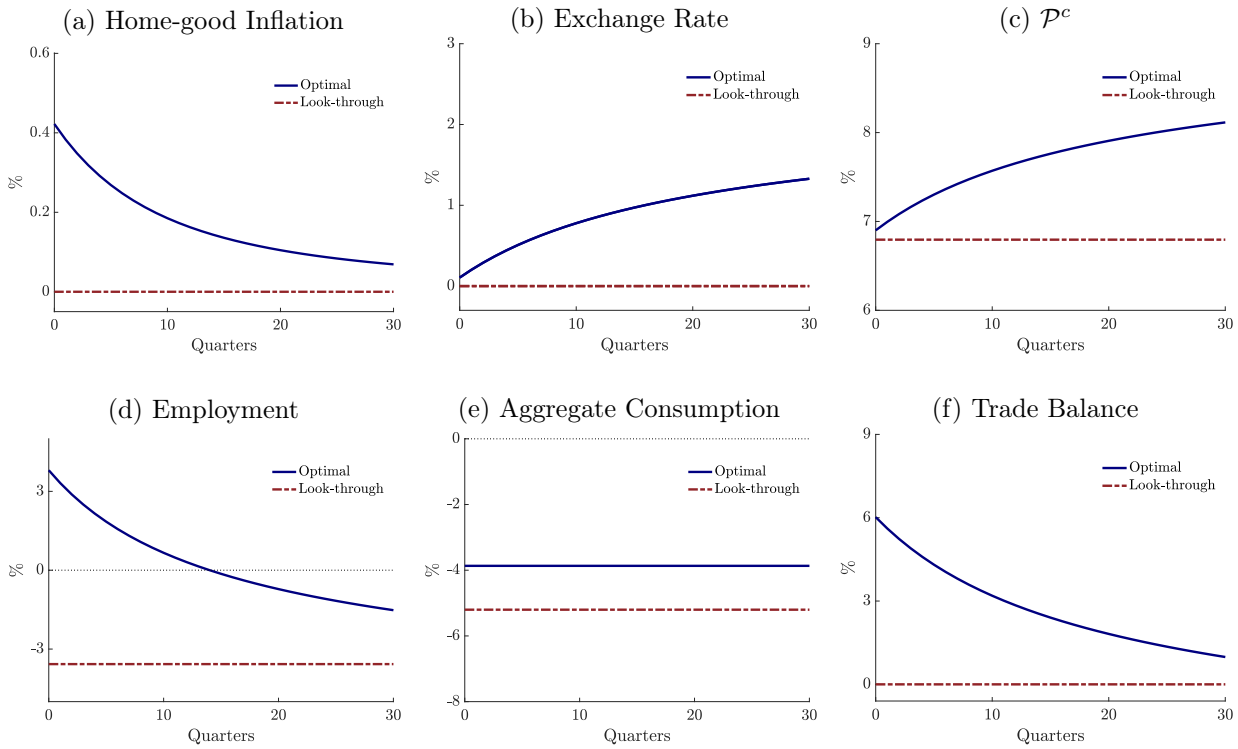


Figure 3: Response to a tariff shock in the model with imported inputs.

Notes: The tariff is imposed on imported consumption goods and intermediate inputs with $\tau_t = 15\%$ for all t. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

$y_t - px_t^f$) falls more than in the baseline (-4.3% vs. -2.4%) because in addition to the tax-like effect on labor supply from consumption tariffs, imported inputs become more expensive. The optimal monetary policy is again expansionary. As the figure shows, the stimulus raises employment by 3.8% (panel d) and GDP expands on impact by 3.6%, whereas employment falls by 3.5% and GDP contracts by 4.3% under look-through.

Our modeling of the look-through policy in the version with imported inputs parallels the baseline model without inputs: we assume that the monetary authority maintains zero inflation in home goods, $\pi_t = 0$. However, unlike the case of tariffs on consumption goods, tariffs on inputs do not directly affect the CPI level. This implies that if tariffs apply only to imported inputs, the price of final consumption goods remains unchanged under a look-through policy. Accordingly, in this case, a look-through policy is equivalent to CPI inflation targeting, as illustrated in Figure B.2 in the appendix.

Just as in the baseline model, there is a fundamental difference in how monetary policy responds to tariffs and terms-of-trade shocks. A TOT shock to the price of intermediate inputs calls for maintaining zero PPI inflation. Under this look-through policy, output falls but the output gap remains at zero (see Figure B.3). In other words, divine coincidence holds in our model for TOT shocks to imported inputs.[25] By contrast, in response to a tariff on imported inputs, the optimal monetary policy is expansionary, leading to inflation and a positive output gap.

5.2 Distorted Steady State

Until now, we have analyzed an initial scenario in which the economy operates at the efficient allocation in the absence of tariffs. This result hinges on the standard assumption that the government has access to a constant production subsidy that offsets the markup distortion. We now consider the case where no such subsidy is in place ($s = 0$), meaning the economy starts from a distorted steady state in the absence of tariffs. Crucially, *we assume that tariff revenue is used to subsidize the wage bill*, and thus the government budget constraint is

$$P_t^f \tau_t c_t^f = s_t W_t \ell_t \tag{32}$$

Notice that now tariffs help mitigate the markup distortion and stimulate employment, even in the absence of monetary stimulus. These effects align with one of the common arguments for tariff proposals: the revenue collected can be used to reduce other distortionary taxes. Indeed, we will show below that there is a potential welfare role for tariffs in this case.

Figure 4 presents the results of this simulation. As shown in panel (d), employment rises even under look-through policy, reflecting that the wage subsidy stimulates labor demand. Furthermore, the fact that the tariff is permanent combined with a neutral monetary stance implies that no changes in the exchange rate or trade balance take place.

To understand the simulations for optimal policy, it is useful to recall that, starting from a distorted steady state with low employment, there is already an incentive to stimulate output. The imposition of a tariff reinforces this incentive by introducing a fiscal externality, as discussed above. As we can see, the optimal monetary policy leads to a significant increase in employment and a rise in inflation. However, much of the rise in inflation reflects the

[25] An analogous version of divine coincidence would hold under sticky wages, in which case the monetary authority would stabilize wage inflation. As is well understood, divine coincidence may fail to hold under both price and wage rigidities. Bodenstein, Guerrieri and Kilian (2012) study the response to oil price shocks with price and wage rigidities and find that a rise in PPI inflation is desirable to help induce a lower real wage.

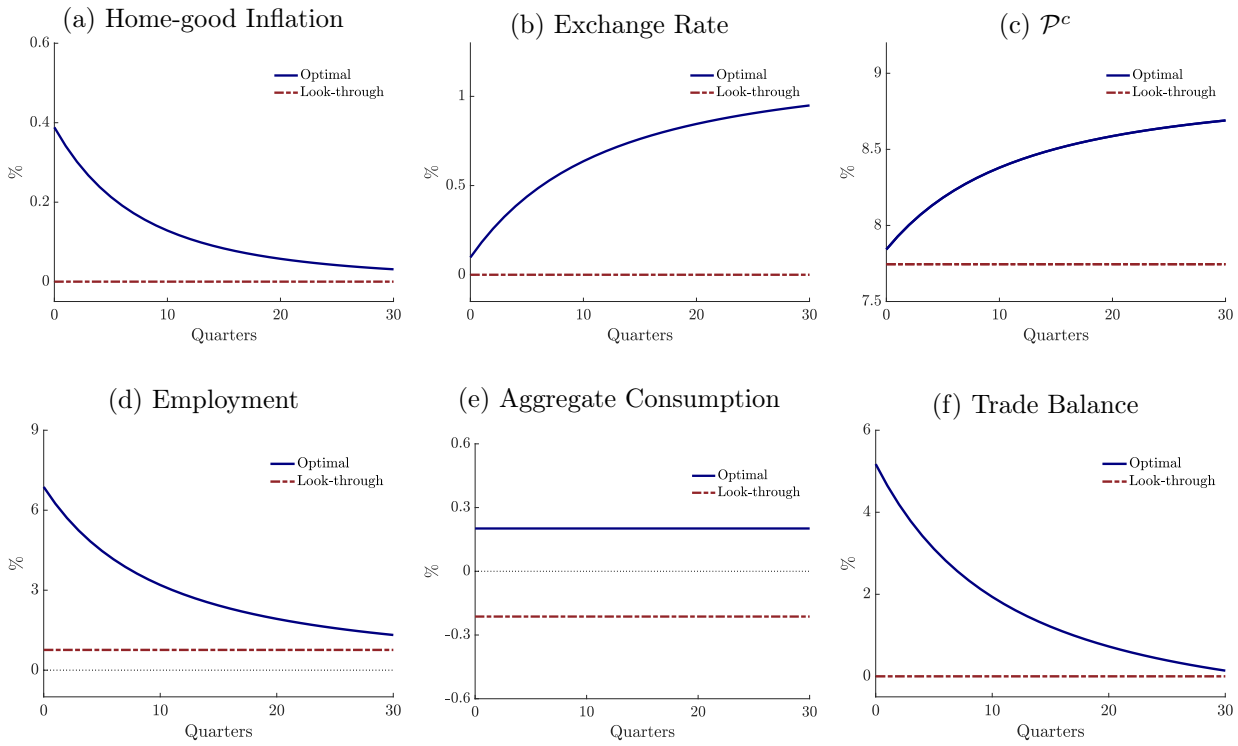


Figure 4: Response to a permanent tariff shock of 15% with a distorted steady state

Notes: The initial allocation has an inefficient steady state ($s = 0$). We assume that tariff revenue collected subsidizes the wage bill: $P_t^f \tau_t c_t^f = s_t W_t \ell_t$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate and the tradable price level are expressed as percentage deviation from the pre-tariff allocation.

pre-existing distortion in the steady state. In fact, the increase in the labor subsidy is a deflationary force, and thus inflation is about the same with and without tariffs (see Figure C.1).

5.3 Endogenous Terms of Trade

In our baseline model, the relative price of home and foreign goods is exogenous. This assumption enables us to abstract from a terms-of-trade manipulation incentive and to focus on demand stabilization. We now extend our analysis to a situation where terms of trade are endogenous.

Following Galí and Monacelli (2005), we assume a continuum of small open economies where the foreign good is a CES composite of goods produced in the rest of the world with

elasticity $\theta > 1$. In equilibrium, this generates an isoelastic foreign demand schedule

$$p_t = A\left(y_t - c_t^h\right)^{\frac{1}{\theta}}, \tag{33}$$

where A is an exogenous shifter that varies inversely with global demand for domestic goods and θ represents the export demand elasticity (see Appendix D.1). Our baseline model corresponds to the limiting case $\theta \to \infty$.

In this Armington setup, since each country is the sole producer of a good that is an imperfect substitute for foreign varieties, a zero tariff is no longer efficient. As shown in Appendix D.2, starting from $b_0 = 0$, the optimal policy for the small open economy implies the following tariff

$$\tau_t^\star = \frac{1}{\theta - 1}, \tag{34}$$

and zero PPI inflation.[26]

The proposition below shows that, starting from this optimal tariff, an increase in tariffs leads the monetary authority to induce a positive output gap. While the proposition starts from $\tau^\star$, the result is more general: starting from any initial tariff, an increase in tariffs leads the monetary authority to induce a higher level of output—even when the resulting tariff remains below $\tau^\star$—just as in the baseline model.

Proposition 5 (Optimal policy under endogenous TOT)**.** *Suppose that Assumption 1 holds, that* $\Upsilon = 0$*, and that* $\tau_t = \tau^\star + \Delta\tau$*, where* $\tau^\star$ *is the optimal tariff given by* (34)*. Then, the labor wedge,* $\wp$*, under the optimal monetary policy satisfies*

$$\wp_t = -\left[1 + \frac{\theta - 1 + \gamma}{\theta}\frac{c^h}{pc^f}\right]^{-1}\frac{\Delta\tau}{1+\tau^\star}.$$

Moreover, $\wp_t < 0$ *if and only if* $\Delta\tau > 0$*.*

We set $\theta = 10$, consistent with Head and Ries (2001), and A such that $p = 1$ in the efficient steady state.[27] Figure D.1 shows the optimal response to a 15-percentage-point increase from the optimal tariff ($\tau^\star = 11.1\%$), that is, to 26.1%. As in our baseline model

[26] We note that the optimal tariff turns out to be the same as the one obtained under balanced trade or in steady state (see Auray et al., 2024). Hence, borrowing and lending do not affect the optimal tariff provided that $b_0 = 0$. Itskhoki and Mukhin (2025) show how the optimal tariff depends on initial currency portfolio positions.

[27] Head and Ries (2001) find that the elasticity of substitution between U.S. and Canadian manufacturing is between 7 and 11.4. This is also in the range of empirical estimates by Broda and Weinstein (2006). Figure D.3 presents simulations with a lower θ.

with exogenous terms of trade, the monetary authority stimulates the economy, raising inflation and employment above both the natural and efficient levels. When terms of trade are endogenous, however, the required monetary stimulus is more modest, because tariffs lower the international price of imports, thereby partially offsetting the increase in prices faced by households.[28]

5.4 Welfare

In this section, we evaluate the welfare implications of tariffs and optimal monetary policy. Table 2 presents the results, where welfare is measured in terms of permanent consumption equivalence. The table reports that in our baseline calibrated model, tariffs result in a sizable welfare loss of 1% under the look-through policy. Moreover, the extension with intermediate inputs reveals that the welfare costs of tariffs become much larger when tariffs apply to inputs. Likewise, the gains from optimal policy become more substantial.

Table 2: Welfare Implications

	Gains from Optimal Policy	Losses from Tariffs	
		Optimal Policy	Look-through
Baseline	0.009	0.99	1.00
Anticipated tariffs	0.008	0.96	0.97
Temporary tariffs	0.001	0.19	0.19
Endogenous TOT	0.007	0.68	0.69
Model with imported inputs			
Tariffs on c and x	0.32	1.61	1.91
Tariffs on c	0.01	1.00	1.01
Tariffs on x	0.22	0.59	0.80

Note: Welfare corresponds to permanent consumption equivalence and is expressed in percent.

While tariffs are unambiguously welfare-reducing in our baseline model, this is not the

[28] We highlight that the equivalence between a TOT shock and a tariff with wasted revenue—as stated in Proposition 3—remains valid. To see this, define $\tilde{p}_t \equiv (1+\tau)p_t$, so that (33) becomes $\tilde{p}_t = (1+\tau)A\left(y_t - c_t^h\right)^{\frac{1}{\theta}}$. Thus, in the equivalent no-tariff economy, the inverse-demand shifter is $(1+\tau)A$, corresponding to a downward shift in direct export demand. In terms of optimal policy, however, owing to the terms-of-trade externality, the optimal monetary policy is no longer directed at stabilizing PPI inflation when tariff revenue is not rebated. Figure D.2 shows that the optimal policy becomes contractionary in response to an increase in tariffs with wasted revenue (or a TOT shock), thereby underscoring the role of the fiscal externality in rationalizing an expansionary monetary response to tariffs.

case in the extension where we consider a distorted steady state. As Figure 5 illustrates, for a range of parameter values, tariffs can indeed raise welfare.

The fact that optimal tariffs are positive implies that home and foreign consumption goods are implicitly taxed at different rates. That this is welfare-improving in our setting is perhaps surprising, given the absence of terms-of-trade manipulation motives and in light of the Diamond and Mirrlees principle of optimal taxation. When the labor subsidy is zero, the economy operates with a positive steady-state markup. In this setting, even though tariffs distort relative consumption, they may improve welfare by lowering the steady-state markup. In particular, starting from zero tariffs, small increases generate only modest welfare costs while delivering strictly positive gains by reducing the labor wedge. Proposition 6 formally establishes this result under a look-through policy (i.e., under flexible prices).

Proposition 6 (Welfare gain from small tariffs)**.** *Consider the flexible-price economy with a constant tariff and a labor subsidy that satisfy* (32)*, and assume that lump-sum taxes are not available. Then, starting from zero tariffs, a marginal increase in tariffs raises welfare.*

Figure 5 also shows that when the elasticity of substitution between home and foreign goods is low (panel a) and imports represent a small fraction of aggregate demand (panel c), tariffs are more likely to raise welfare.[29] Intuitively, when either the elasticity is low or the share of imports in final consumption is small, a tariff induces a smaller distortion in relative consumption. In this case, the reduction in the labor wedge financed by tariff revenue more than offsets the tariff's distortion.[30]

5.5 CPI Targeting

We adopt as our benchmark the "look-through policy," under which the monetary authority targets PPI inflation. We now turn to a policy that targets CPI inflation, a more common framework for central banks. In particular, the policy rate follows

$$R_t = \bar{R}_t \left(\frac{\mathcal{P}_t^c}{\mathcal{P}_{t-1}^c} \right)^{\phi_\pi}, \quad \text{with} \quad \bar{R}_t \equiv R^* \frac{e_{t+1}}{\bar{e}_t}, \tag{35}$$

where $\bar{e}_t$ denotes the natural exchange rate at date t (i.e., the one consistent with the flexible-price allocation) and $\phi_\pi > 0$ measures the responsiveness of the policy rate to CPI inflation.

[29] The welfare losses from tariffs under optimal policy follow the same pattern as in Figure 5.

[30] In two recent related papers, Klenow, Pastén and Ruane (2024) show that a tax on imports of energy can raise output and welfare through reallocation toward high-markup firms with low energy use, and Alessandria, Ding, Khan and Mix (2025a) explore how fiscal reforms that include tariffs on imports can raise welfare by reducing reliance on labor and capital taxes.

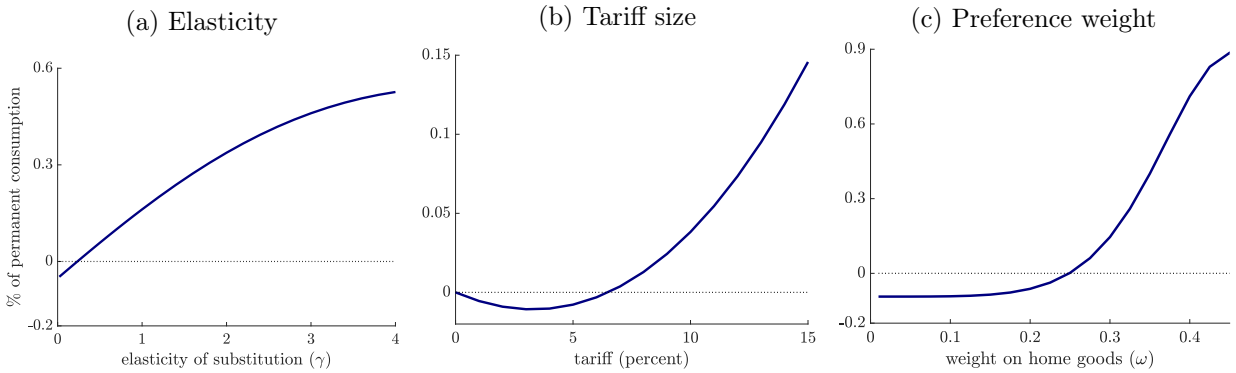


Figure 5: Welfare effects of tariffs under look-through policy when the steady state is distorted

Note: The initial allocation has a distorted steady state ($s = 0$). We assume that tariff revenue collected subsidizes the wage bill: $P_t^f \tau_t c_t^f = s_t W_t \ell_t$. Except for the parameter on the x-axis, all parameters are set to their baseline values.

When $\phi_\pi = 0$, the rule coincides with the look-through policy, while $\phi_\pi \to \infty$ corresponds to strict CPI targeting.

Appendix F presents simulations comparing the optimal policy with CPI targeting at $\phi_\pi = 1.5$, for the baseline model under permanent, temporary, and anticipated tariffs (Figures F.1, F.2, and F.3), as well as for the extensions with endogenous terms of trade and with imported inputs (Figures F.4 and F.5). As the figures show, CPI targeting requires a monetary tightening, leading to worse macroeconomic outcomes relative to look-through. Moreover, as reported in Table F.1, the stronger the central bank's response to CPI inflation deviations, the greater the welfare losses from tariffs—and the larger the welfare gains from following the optimal policy.

6 Conclusion

Tariffs are back as a policy tool. The contribution of this paper is to develop a theory of the optimal monetary policy response for a country imposing unilateral tariffs on the rest of the world. We show that tariffs affect output through a labor-supply channel that operates even without movements in exchange rates or terms of trade. Owing to a fiscal externality created by tariffs, the Ramsey optimal response is expansionary, with inflation rising above and beyond the direct effects of tariffs. Moreover, the monetary authority induces the economy to overheat: when the IES is below one, it raises output not only above the natural level but also above the efficient level. The theory also yields positive implications for exchange rates

and external adjustment: tariffs can induce a depreciation of the nominal exchange rate and a reduction in trade deficits even for permanent tariffs.

Our approach first considers a simple environment where price adjustment costs are rebated and international relative prices are exogenous. This setting yields closed-form solutions for optimal policy and admits a tractable reformulation in which the planner directly chooses the level of employment, while households determine the composition of consumption across home and foreign goods. To extend these findings, we solve the model quantitatively, calibrated to the U.S. economy, and show that the desirability of an expansionary monetary policy holds across a range of cases: whether tariffs apply to consumption goods or intermediate inputs, whether shocks are temporary or permanent, and whether international relative prices are exogenous or endogenous. In addition, when tariffs are introduced in an economy with a positive steady-state markup and the revenues are used to lower firms' labor costs, the inflationary effects are attenuated and small tariffs can improve welfare.

We conclude by emphasizing that our model abstracts from several important considerations, including trade wars and broader strategic and geopolitical factors. Incorporating these dimensions and analyzing their theoretical and quantitative implications for monetary policy remains an important avenue for future research.

References

Afrouzi, Hassan, Marina Halac, Kenneth S Rogoff, and Pierre Yared, "Monetary Policy without Commitment," 2023. NBER Working Paper No. 31207.

_ , Saroj Bhattarai, and Edson Wu, "Relative-price changes as aggregate supply shocks revisited: Theory and evidence," *Journal of Monetary Economics*, 2024, *148*, 103650.

Aguiar, Mark, Manuel Amador, and Doireann Fitzgerald, "Tariff Wars and Net Foreign Assets," April 2025. Mimeo, Princeton.

Alessandria, George A, Jiaxiaomei Ding, Shafaat Y Khan, and Carter B Mix, "The Tariff Tax Cut: Tariffs as Revenue," Technical Report 33784, National Bureau of Economic Research 2025.

Alessandria, George, Shafaat Yar Khan, Armen Khederlarian, Kim J Ruhl, and Joseph B Steinberg, "Trade Policy Dynamics: Evidence from 60 Years of US-China Trade," *Journal of Political Economy*, 2025, *133* (3), 713–749.

Ambrosino, Ludovica, Jenny Chan, and Silvana Tenreyro, "Trade Fragmentation, Inflationary Pressures, and Monetary Policy," 2024. BIS Working Paper.

Amiti, Mary, Stephen J Redding, and David E Weinstein, "The Impact of the 2018 Tariffs on Prices and Welfare," *Journal of Economic Perspectives*, 2019, *33* (4), 187–210.

Antonova, Anastasiia, Luis Huxel, Mykhailo Matvieiev, and Gernot J Müller, "The Propagation of Tariff Shocks via Production Networks," 2025. CESifo Working Paper.

Aoki, Kosuke, "Optimal Monetary Policy Responses to Relative-price Changes," *Journal of Monetary Economics*, 2001, *48* (1), 55–80.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub, "The macroeconomics of tariff shocks," 2025. National Bureau of Economic Research.

Auray, Stéphane, Michael B Devereux, and Aurélien Eyquem, "Self-enforcing Trade Policy and Exchange Rate Adjustment," *Journal of International Economics*, 2022, *134*.

_ , _ , and _ , "Trade Wars, Nominal Rigidities, and Monetary Policy," *Review of Economic Studies*, 2024.

_ , _ , and _ , "Trade Wars and the Optimal Design of Monetary Rules," *Journal of Monetary Economics*, 2025, *151*.

Baqaee, David R, Emmanuel Farhi, and Kunal Sangani, "The Supply-side Effects of Monetary Policy," *Journal of Political Economy*, 2024, *132* (4).

Barattieri, Alessandro, Matteo Cacciatore, and Fabio Ghironi, "Protectionism and the Business Cycle," *Journal of International Economics*, 2021, *129*, article 103417.

Barbiero, Omar, Emmanuel Farhi, Gita Gopinath, and Oleg Itskhoki, "The Macroeconomics of Border Taxes," *NBER Macroeconomics Annual*, 2019, *33* (1), 395–457.

Benguria, Felipe and Felipe Saffie, "Rounding up the Effect of Tariffs on Financial Markets: Evidence from April 2, 2025," 2025. NBER Working Paper No. 34036.

Benigno, Pierpaolo, "Optimal monetary policy in a currency area," *Journal of International Economics*, 2004, *63* (2), 293–320.

Bergin, Paul and Giancarlo Corsetti, "Monetary stabilization of sectoral tariffs," Technical Report, National Bureau of Economic Research 2025.

Bergin, Paul R, and Giancarlo Corsetti, "The macroeconomic stabilization of tariff shocks: What is the optimal monetary response?," *Journal of International Economics*, 2023, *143*, article 103758.

Bernanke, Ben and Olivier Blanchard, "What caused the US pandemic-era inflation?," 2023. Peterson Institute for International Economics.

Bianchi, Javier, Alisdair McKay, and Neil Mehrotra, "How should monetary policy respond to housing inflation?," 2024. Working paper 808, Federal Reserve Bank of Minneapolis.

_ **and Louphou Coulibaly**, "Financial Integration and Monetary Policy Cooperation," 2024. NBER Working Paper 32009.

Bodenstein, Martin, Luca Guerrieri, and Lutz Kilian, "Monetary policy responses to oil price fluctuations," *IMF Economic Review*, 2012, *60* (4), 470–504.

Boehm, Christoph E, Andrei A Levchenko, and Nitya Pandalai-Nayar, "The Long and Short (Run) of Trade Elasticities," *American Economic Review*, 2023, *113* (4), 861–905.

Broda, Christian and David Weinstein, "Globalization and the Gains from Variety," *Quarterly Journal of Economics*, 2006, *121* (2), 541–585.

Caldara, Dario, Matteo Iacoviello, Patrick Molligo, Andrea Prestipino, and Andrea Raffo, "The economic effects of trade policy uncertainty," *Journal of Monetary Economics*, 2020, *109*, 38–59.

Caliendo, Lorenzo and Fernando Parro, "Trade policy," *Handbook of International Economics*, 2022, *5*, 219–295.

_ **, Samuel S Kortum, and Fernando Parro**, "Tariffs and Trade Deficits," 2025. NBER Working Paper No. 34003.

Cavallo, Alberto, Gita Gopinath, Brent Neiman, and Jenny Tang, "Tariff pass-through at the border and at the store: Evidence from US trade policy," *American Economic Review: Insights*, 2021, *3* (1), 19–34.

Clarida, Richard, Jordi Galí, and Mark Gertler, "A Simple Framework for International Monetary Policy Analysis," *Journal of Monetary Economics*, 2002, *49* (5), 879–904.

Comin, Diego A and Robert C Johnson, "Offshoring and inflation," 2021. NBER Working Paper No. 27957.

Costinot, Arnaud, and Iván Werning, "Lerner symmetry: A modern treatment," *American Economic Review: Insights*, 2019, *1* (1), 13–26.

Costinot, Arnaud and Iván Werning, "How Tariffs Affect Trade Deficits," April 2025. Mimeo, MIT.

Cuba-Borda, Pablo, Albert Queralto, Ricardo Reyes-Heroles, and Mikaël Scaramucci, "Trade Costs and Inflation Dynamics," 2024. FRB of Dallas Working Paper.

Dávila, Eduardo, Andrés Rodríguez-Clare, Andreas Schaab, and Stacy Tan, "A Dynamic Theory of Optimal Tariffs," 2025. NBER Working Paper No. 33898.

den Besten, Tamar, Regis Barnichon, Diego R Känzig, and Aayush Singh, "The macroeconomic effects of tariffs: Insights from 180 years of U.S. trade policy," 2026.

di Giovanni, Julian, Şebnem Kalemli-Özcan, Alvaro Silva, and Muhammed A Yildirim, "Global Supply Chain Pressures, International Trade, and Inflation," 2022. NBER Working Paper No. 30240.

Diamond, Peter A and James A Mirrlees, "Optimal taxation and public production I: Production efficiency," *American Economic Review*, 1971, *61* (1), 8–27.

Eichengreen, Barry, "Trade policy and the macroeconomy," *IMF Economic Review*, 2019, *67 (1)*, 4–23.

Eichengreen, Barry J, "A dynamic model of tariffs, output and employment under flexible exchange rates," *Journal of International Economics*, 1981, *11* (3), 341–359.

Erceg, Christopher, Andrea Prestipino, and Andrea Raffo, "Trade Policies and Fiscal Devaluations," *American Economic Journal: Macroeconomics*, 2023, *15* (4), 104–140.

Fajgelbaum, Pablo, Pinelopi Goldberg, Patrick Kennedy, and Amit Khandelwal, "The return to protectionism," *The Quarterly Journal of Economics*, 2020, *135* (1), 1–55.

Fornaro, Luca and Federica Romei, "Monetary policy in an unbalanced global economy," 2023. Working Paper 1313, Barcelona School of Economics.

Gagliardone, Luca and Mark Gertler, "Oil prices, monetary policy and inflation surges," 2023. NBER Working Paper No. 31263.

Galí, Jordi, *Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework and its applications*, Princeton University Press, 2015.

Galí, Jordi and Tommaso Monacelli, "Monetary policy and exchange rate volatility in a small open economy," *Review of Economic Studies*, 2005, *72* (3), 707–734.

Gopinath, Gita and Brent Neiman, "The Incidence of Tariffs: Rates and Reality," 2026. NBER Working Paper No. 34620.

Guerrieri, Veronica, Guido Lorenzoni, and Iván Werning, "Global Price Shocks and International Monetary Coordination," 2025. NBER Working Paper No. 33840.

_ , _ , **Ludwig Straub, and Iván Werning**, "Monetary Policy in Times of Structural Reallocation," 2021. Jackson Hole Economic Policy Symposium, Federal Reserve Bank of Kansas City.

_ , _ , _ , **and** _ , "Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?," *American Economic Review*, 2022, *112* (5), 1437–1474.

Harberger, Arnold C., "Currency Depreciation, Income, and the Balance of Trade," *Journal of Political Economy*, February 1950, *58* (1), 47–60.

Hazell, Jonathon, Juan Herreño, Emi Nakamura, and Jón Steinsson, "The Slope of the Phillips Curve: Evidence from US states," *The Quarterly Journal of Economics*, 2022, *137* (3), 1299–1344.

Head, K. and J. Ries, "Increasing Returns versus National Product Differentiation as an Explanation for the Pattern of US-Canada trade," *American Economic Review*, 2001, *91*, 858–876.

Hevia, Constantino and Juan Pablo Nicolini, "Optimal devaluations," *IMF Economic Review*, 2013, *61* (1), 22–51.

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

Itskhoki, Oleg and Dmitry Mukhin, "The Optimal Macro Tariff," 2025. Mimeo, Harvard.

Jeanne, Olivier, "Currency wars, trade wars, and global demand," 2021. NBER Working Paper No. 29603.

_ **and Jeongwon Son**, "To what extent are tariffs offset by exchange rates?," *Journal of International Money and Finance*, 2024, *142*, 103015.

Jiang, Zhengyang, Arvind Krishnamurthy, Hanno N Lustig, Robert Richmond, and Chenzi Xu, "Dollar upheaval: This time is different," 2025. Mimeo, Northwestern.

Kalemli-Özcan, Şebnem, Can Soylu, and Muhammed A. Yildirim, "Global Networks, Monetary Policy and Trade," 2025. NBER Working Paper.

Keynes, John Maynard, "The General Theory of Employment," *Quarterly Journal of Economics*, 1937, *51* (2), 209–223.

Klenow, Peter J, Ernesto Pastén, and Cian Ruane, "Carbon taxes and misallocation in Chile," 2024. Mimeo, Stanford.

Krugman, Paul, "The macroeconomics of protection with a floating exchange rate," in "Carnegie-Rochester Conference Series on Public Policy," Vol. 16 North-Holland Amsterdam 1982, pp. 141–182.

Kugler, Adriana, "Inflation Dynamics and the Phillips Curve," 2025. At Ec 10b Principles of Economics Lecture, Harvard University.

La'O, Jennifer and Alireza Tahbaz-Salehi, "Optimal monetary policy in production networks," *Econometrica*, 2022, *90* (3), 1295–1336.

Laursen, Svend and Lloyd A. Metzler, "Flexible Exchange Rates and the Theory of Employment," *Review of Economics and Statistics*, November 1950, *32* (4), 281–299.

Lindé, Jesper, and Andrea Pescatori, "The macroeconomic effects of trade tariffs: Revisiting the Lerner symmetry result," *Journal of International Money and Finance*, 2019, *95*, 52–69.

Lloyd, Simon P, and Emile A Marin, "Capital controls and trade policy," *Journal of International Economics*, 2024, *151*, 103965.

Monacelli, Tommaso, "Tariffs and Monetary Policy," 2025. Mimeo, Bocconi.

Mundell, Robert, "Flexible exchange rates and employment policy," *Canadian Journal of Economics and Political Science*, 1961, *27* (4), 509–517.

Razin, Assaf and Lars EO Svensson, "Trade taxes and the current account," *Economics Letters*, 1983, *13* (1), 55–57.

Rodríguez-Clare, Andrés, Feodora Teti, Mauricio Ulate, Jose P Vasquez, and Roman D Zarate, "The 2025 trade war: Dynamic impacts across US States and the global economy," 2025. NBER Working Paper No. 33792.

_ , Mauricio Ulate, and Jose P Vasquez, "Trade with nominal rigidities: Understanding the unemployment and welfare effects of the China shock," *Journal of Political Economy*, 2026, *134* (2).

Rotemberg, Julio, "Sticky prices in the United States," *Journal of Political Economy*, 1982, *90* (6), 1187–1211.

Rubbo, Elisa, "Networks, Phillips Curves, and Monetary Policy," *Econometrica*, 2023, *91* (6), 1417–1455.

Schmitt-Grohé, Stephanie and Martín Uribe, "Stabilization policy and the costs of dollarization," *Journal of Money, Credit and Banking*, 2001, pp. 482–509.

_ and _ , "Transitory and Permanent Import Tariff Shocks in the United States: An Empirical Investigation," 2025. NBER Working Paper No. 33997.

Steinberg, Joseph B, "Brexit and the macroeconomic impact of trade policy uncertainty," *Journal of International Economics*, 2019, *117*, 175–195.

Waller, Christopher J., "Challenges Facing Central Bankers," 2025. At Lectures of the Governor, Organization for Economic Cooperation and Development, Paris, France, January 8, 2025. https://www.federalreserve.gov/newsevents/speech/waller20250108a.htm.

_ , "A Tale of Two Outlooks," 2025. At the Certified Financial Analysts Society of St. Louis, St. Louis, Missouri. https://www.federalreserve.gov/newsevents/speech/waller20250414a.htm.

Werning, Iván, Guido Lorenzoni, and Veronica Guerrieri, "Tariffs as Cost-Push Shocks: Implications for Optimal Monetary Policy," Technical Report, National Bureau of Economic Research 2025.

Woodford, Michael, *Interest and prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, 2003.

_ , "Effective demand failures and the limits of monetary stabilization policy," *American Economic Review*, 2022, *112* (5), 1475–1521.

Appendix

A Proofs

A.1 Proof of Proposition 2

Proof. Using the functional form for u and c, and (15), we obtain

$$u_h(c_t^h, c_t^f) = \omega(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\sigma(\gamma-1)}}(c_t^h)^{-\frac{1}{\sigma}} \tag{A.1}$$

Plugging this expression into (16) and using $\beta R^* = 1$, we arrive at $c_t^h = c_{t+1}^h$ for all t, and from (15), it follows that c_t^f is also constant.

Replacing these expressions in (13)-(16), and using $\pi_t = 0$ for all t, we obtain

$$\ell^{look} = \left[\frac{\Theta_\tau + \tau}{1+\tau}(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}},$$

$$c^{h,look} = \frac{1+\tau}{\Theta_\tau+\tau}\left[\frac{\Theta_\tau + \tau}{1+\tau}(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}},$$

$$c^{f,look} = \frac{\Theta_\tau - 1}{p(\Theta_\tau+\tau)}\left[\frac{\Theta_\tau + \tau}{1+\tau}(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}}$$

which yields the expressions in the proposition.

Under the optimal policy, the Ramsey planner (17) can be rewritten as

$$\max_{c^h,\ell} \frac{(\omega\Theta_\tau)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}}}{1-\sigma^{-1}} \left(c^h\right)^{1-\frac{1}{\sigma}} - \omega\frac{\ell^{1+\psi}}{1+\psi}$$

$$\text{subject to} \quad \frac{\Theta_\tau+\tau}{1+\tau}c^h = \ell,$$

The solution to this problem is

$$\ell = \left[\left(\frac{1+\tau}{1+\Theta_\tau^{-1}\tau}\right)^\sigma \frac{\Theta_\tau+\tau}{1+\tau}\left(\omega\Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}},$$

$$c^h = \frac{1+\tau}{\Theta_\tau+\tau}\left[\left(\frac{1+\tau}{1+\Theta_\tau^{-1}\tau}\right)^\sigma \frac{\Theta_\tau+\tau}{1+\tau}\left(\omega\Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}},$$

$$c^f = \frac{\Theta_\tau-1}{p(\Theta_\tau+\tau)}\left[\left(\frac{1+\tau}{1+\Theta_\tau^{-1}\tau}\right)^\sigma \frac{\Theta_\tau+\tau}{1+\tau}\left(\omega\Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}}.$$

These are the expressions for optimal policy in the proposition. In addition, given that $\Theta_\tau > 1$, we have that $\frac{1+\tau}{1+\Theta_\tau^{-1}\tau} > 1$. Thus, $\ell^{opt} \geq \ell^{look}$, with strict inequality if $\tau > 0$.

Finally, we use (15), (A.1), and a constant level of inflation $\pi_t = \pi$, and obtain

$$\begin{aligned}(1+\pi)\pi &= \frac{\varepsilon}{\varphi}\sum_{t=0}^{\infty}\beta^t\left[\left(\omega\Theta_\tau\right)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}}\left(c^h\right)^{\frac{1}{\sigma}}\ell^\psi - 1\right] \\ &= \frac{\varepsilon}{\varphi(1-\beta)}\frac{\left(\Theta_\tau-1\right)\tau}{\Theta_\tau+\tau} > 0\end{aligned}$$

Given that a root with $\pi < -1$ cannot be a solution and $\Theta_\tau > 1$, the optimal policy therefore implies $\pi > 0$. □

A.2 Proof of Corollaries 1 and 2

Proof. Corollary 1 follows directly from differentiating (18) with respect to τ, and Corollary 2 follows from differentiating (19) with respect to τ.

□

A.3 Proof of Proposition 3

Proof. When the tariff revenue is wasted, the Ramsey problem is given by

$$\max_{\{c_t^h, c_t^f, \ell_t, \pi_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c_t^h, c_t^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right],$$

subject to

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega \ell_t^{\psi}}{u_h(c_t^h, c_t^f)} - 1\right] + \frac{1}{R^*}\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \qquad [\eta_t] \qquad \text{(A.2)}$$

$$c_t^f = \left[\frac{1-\omega}{\omega p(1+\tau)}\right]^{\gamma} c_t^h, \qquad [\xi] \qquad \text{(A.3)}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f), \qquad \text{(A.4)}$$

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c_t^h + p(1+\tau)c_t^f - \left(1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right)\ell_t \right], \qquad [\lambda] \qquad \text{(A.5)}$$

where, as in (14), we used the Euler equation (A.4) to substitute $\beta\, u_h(c_{t+1}^h, c_{t+1}^f)/u_h(c_t^h, c_t^f) = 1/R^*$ into the Phillips curve. It is immediate that the competitive equilibrium conditions are the same if the terms of trade are given by $p(1+\tau)$ and tariffs are zero. Therefore, for any policy of the monetary authority, allocations are the same.

To solve for the optimal policy when tariff revenue is not rebated, we guess and verify that only the last constraint binds. In this case, it is then immediate that $\pi_t = 0$ is optimal and that (A.2) holds. In addition, the first-order conditions for c_t^f and c_t^h yield (A.3), verifying that only the intertemporal budget constraint (A.5) binds.

Moreover, we have that under Assumption 1 the solution is given by

$$\begin{aligned}
\omega \ell^{\psi} = u_h(c^h, c^f) \quad &\Longleftrightarrow \quad \ell^{\psi} = (\omega \Theta_\tau)^{\frac{\sigma-\gamma}{\sigma(\gamma-1)}} (c^h)^{-\frac{1}{\sigma}} \\
\ell = c^h + p(1+\tau)c^f \quad &\Longleftrightarrow \quad \ell = \Theta_\tau c^h \\
c^f = \left[\frac{1-\omega}{\omega p(1+\tau)}\right]^{\gamma} c^h \quad &\Longleftrightarrow \quad c^f = \frac{\Theta_\tau - 1}{p(1+\tau)} c^h,
\end{aligned}$$

Together, these conditions yield (22). □

A.4 Proof of Proposition 4

Proof. The solution to the Ramsey optimal policy problem is given by (23), (24), (26)-(30). Using (24) and (29), we rewrite (28) as

$$\omega = \left[1 - \frac{1}{1+2\pi_t}\frac{\varphi}{2}\pi_t^2 + \left(\beta\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1} - (1+\pi_t)\pi_t\right)\frac{\eta_t}{\ell_t}\right]\lambda. \tag{A.6}$$

Combining (26) and (27), we get

$$\lambda = \Xi\frac{\Theta_\tau\,(1+\tau)}{\Theta_\tau+\tau}u_h\left(c^h, c^f\right) \tag{A.7}$$

where $\Xi \equiv 1 - \frac{\varepsilon}{\varphi\sigma}\frac{\wp(1-\wp)}{\Theta_\tau c^h}\sum_{t=0}^{\infty}(1-\beta)\beta^t\eta_t$. From (29) we have

$$\frac{\eta_t}{\ell_t} = \varphi\lambda\sum_{k=0}^{t}\frac{\pi_k}{1+2\pi_k}.$$

A first-order approximation of (A.6) and Ξ around $\pi_t = 0$ yields $\lambda = \omega$ and $\Xi = 1$. Replacing these in (A.7) we arrive at

$$\omega = \frac{\Theta_\tau(1+\tau)}{\Theta_\tau+\tau}u_h\left(c_t^h, c_t^f\right)$$

Finally, using that $\wp_t = 1 - \frac{\omega}{u_h(c^h,c^f)}$ in the limit $\psi \to 0^+$, we arrive at

$$\wp = -\tau\frac{\Theta_\tau - 1}{\Theta_\tau+\tau} < 0.$$

□

A.5 Proof of Proposition 5

Proof. Following the same steps as in Proposition 2, we can then write the monetary authority's problem as

$$\max_{\ell,c^f,c^h}\; u\left(c^h, c^f\right) - \omega\frac{\ell^{1+\psi}}{1+\psi}$$

$$\text{s.t.}\quad c^f = \left(\ell - c^h\right)^{-\frac{\gamma}{\theta}}\left(\frac{1-\omega}{\omega A(1+\tau)}\right)^{\gamma}c^h \tag{A.8}$$

$$\ell = c^h + A(\ell - c^h)^{\frac{1}{\theta}}c^f \tag{A.9}$$

Denoting by ξ and λ the Lagrange multipliers on (A.8) and (A.9), the first-order conditions for c^f, c^h and ℓ are given by

$$u_f(c^h, c^f) - \xi = \lambda p \tag{A.10}$$

$$u_h(c^h, c^f) + \left[\frac{c^f}{c^h} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\right]\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{A.11}$$

$$\omega\left(\ell\right)^{\psi} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{A.12}$$

Combining (A.11) and (A.12), we obtain

$$1 - \frac{\omega\left(\ell\right)^{\psi}}{u_h(c^h, c^f)} = -\frac{c^f}{c^h u_h(c^h, c^f)}\xi \tag{A.13}$$

Note that the left-hand side of (A.13) is the labor wedge $\wp \equiv 1 - \frac{\omega \ell^{\psi}}{u_h(c^h, c^f)}$. Next, combining (A.10) and (A.11) and using $\ell - c^h = pc^f$ from (A.9), we get

$$\begin{aligned}\xi &= p\left[\tau - \frac{1}{\theta}(1+\tau)\right]\left[\frac{\theta - 1}{\theta} + \frac{pc^f}{c^h} + \frac{\gamma}{\theta}\right]^{-1} u_h(c^h, c^f) \\ &= p\frac{\Delta\tau}{1+\tau^{\star}}\left[\frac{\theta - 1 + \gamma}{\theta} + \frac{pc^f}{c^h}\right]^{-1} u_h\left(c^h, c^f\right)\end{aligned} \tag{A.14}$$

where we used $\tau = \tau^{\star} + \Delta\tau$ with $\tau^{\star} \equiv \frac{1}{\theta - 1}$. Plugging (A.14) into (A.13), we arrive at

$$\wp = -\left[1 + \frac{\theta - 1 + \gamma}{\theta}\frac{c^h}{pc^f}\right]^{-1}\frac{\Delta\tau}{1+\tau^{\star}}.$$

□

Online Appendix to "The Optimal Monetary Policy Response to Tariffs"

Javier Bianchi and Louphou Coulibaly

B Extension with Imported Intermediate Inputs

B.1 Analytical Derivations

The household problem is identical to that in the baseline model. As in Section 2, there are two types of firms: intermediate and final good producers. The problem of final good producers remains the same. The intermediate-good producer firm produces a variety j out of labor ℓ_{jt} and intermediate inputs x^f_{jt} according to $y_{jt}=(\ell_{jt})^{1-\nu}(x^f_{jt})^{\nu}$. Cost minimization requires that firms optimally split expenditures on labor and imported inputs according to

$$p(1+\tau^x_t)x^f_{jt}=\frac{\nu}{1-\nu}\,\frac{W_t}{P^h_t}\ell_{jt}.$$

The problem of the firm is analogous to (5). To ensure that the steady state is efficient, the subsidy s applies to production, as in the baseline model, rather than to the wage bill, which would distort the factor mix between labor and imported inputs. We have the following dynamic Phillips curve

$$(1+\pi_t)\pi_t=\frac{\varepsilon}{\varphi}\left[mc_t-1\right]+\beta\frac{u_h(c^h_{t+1},c^f_{t+1})}{u_h(c^h_t,c^f_t)}\frac{y_{t+1}}{y_t}(1+\pi_{t+1})\pi_{t+1},$$

where the real marginal cost of production is given by

$$mc_t=\left(\frac{W_t}{(1-\nu)P^h_t}\right)^{1-\nu}\left(\frac{p(1+\tau^x_t)}{\nu}\right)^{\nu},$$

where τ^x_t is the tariff on imported inputs. Firms' profits transferred to households are now given by

$$\frac{D_t}{P^h_t}=(1+s)y_t-\frac{W_t}{P^h_t}\ell_t-p(1+\tau^x_t)x^f_t-\Upsilon\frac{\varphi}{2}\pi_t^2\,y_t. \tag{B.1}$$

The government budget constraint satisfies

$$P^f_t(\tau^c_t c^f_t+\tau^x_t x^f_t)=T_t+s\,P^h_t y_t. \tag{B.2}$$

Combining (B.1) and (B.2) with the households' budget constraint, we arrive at (31).

Optimal Monetary Policy. Taking as given the sequence of tariffs for inputs and consumption goods $\{\tau_t^x, \tau_t^c\}$, the monetary authority chooses the competitive equilibrium that maximizes social welfare. We can write the problem as follows:

$$\max_{\{b_{t+1},\pi_t,\ell_t,x_t^f,c_t^f,c_t^h\}} \sum_{t=0}^{\infty} \beta^t \left[u(c_t^h, c_t^f) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right],$$

subject to

$$\begin{aligned}
c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} &= b_t + \left[1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right] \; y_t - px_t^f \\
(1+\pi_t)\pi_t &= \frac{\varepsilon}{\varphi}\left[\left(\frac{\omega \ell_t^{\psi}}{(1-\nu)u_h(c_t^h, c_t^f)}\right)^{1-\nu}\left(\frac{p(1+\tau_t^x)}{\nu}\right)^{\nu} - 1\right] + \frac{1}{R^*}\frac{y_{t+1}}{y_t}(1+\pi_{t+1})\pi_{t+1}, \\
c_t^f &= \left[\frac{1-\omega}{\omega p(1+\tau_t^c)}\right]^{\gamma} c_t^h, \\
p(1+\tau_t^x)x_t^f &= \frac{\nu}{1-\nu}\frac{\omega \ell_t^{\psi+1}}{u_h(c_t^h, c_t^f)} \\
u_h(c_t^h, c_t^f) &= \beta R^* u_h(c_{t+1}^h, c_{t+1}^f) \\
y_t &= (\ell_t)^{1-\nu}(x_t^f)^{\nu}
\end{aligned}$$

B.2 Intermediate inputs: The Case with $\Upsilon = 0$

Assume $\beta R^* = 1$ and $b_0 = 0$, and suppose that

$$\tau_t^c = 0, \qquad \tau_t^x = \tau^x > 0 \quad \text{for all } t.$$

Since $\tau^c = 0$, the household's consumption mix satisfies

$$c^f = \chi c^h, \qquad \chi \equiv \left(\frac{1-\omega}{\omega p}\right)^{\gamma}.$$

Define

$$\Theta \equiv 1 + p\chi.$$

Let

$$w \equiv \frac{\omega \ell^{\psi}}{u_h(c^h, c^f)}$$

denote the real consumption wage. Using the conditions derived in Appendix B.1, a stationary

allocation satisfies

$$\Theta c^h = \ell^{1-\nu}(x^f)^\nu - px^f \equiv GDP,$$
$$p(1+\tau^x)x^f = \frac{\nu}{1-\nu} w\ell, \tag{B.3}$$
$$mc = \left(\frac{w}{1-\nu}\right)^{1-\nu} \left(\frac{p(1+\tau^x)}{\nu}\right)^{\nu}. \tag{B.4}$$

We define the labor wedge as

$$\wp \equiv 1 - \frac{\omega \ell^\psi / u_h(c^h, c^f)}{(1-\nu)\ell^{-\nu}(x^f)^\nu}.$$

Firm cost minimization implies

$$\frac{\omega \ell^\psi}{u_h(c^h, c^f)} = mc(1-\nu)\ell^{-\nu}(x^f)^\nu.$$

Therefore, the labor wedge can equivalently be written as

$$\wp = 1 - mc.$$

Look-through. Under look-through, $\pi = 0$. The stationary Phillips curve therefore implies $mc = 1$. Combining this condition with (B.3)–(B.4), and defining $\kappa^{look} \equiv x^f/\ell$, gives

$$\kappa^{look} = \left(\frac{\nu}{p(1+\tau^x)}\right)^{\frac{1}{1-\nu}}.$$

Log-differentiating the resource and factor-demand conditions along the look-through allocation yields

$$\frac{d \log GDP^{look}}{d\tau^x} = -\frac{\sigma\nu\left[(1+\psi)\tau^x + 1 - \nu\right]}{(1+\sigma\psi)(1-\nu)(1+\tau^x)(1-\nu+\tau^x)} < 0.$$

In particular,

$$\left.\frac{dGDP^{look}}{d\tau^x}\right|_{\tau^x=0} = -\frac{\sigma}{1+\sigma\psi} px^f < 0.$$

Thus, a marginal input tariff strictly reduces GDP under look-through.

Optimal monetary policy. The static Ramsey problem is

$$\begin{aligned} \max_{c^h, x^f, \ell} \quad & u(c^h, \chi c^h) - \omega \frac{\ell^{1+\psi}}{1+\psi} \\ \text{subject to} \quad & \ell^{1-\nu}(x^f)^\nu - p x^f - \Theta c^h = 0, \qquad [\lambda], \\ & x^f - \frac{\nu}{(1-\nu)p(1+\tau^x)} (\omega\Theta)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} (c^h)^{1/\sigma} \ell^{1+\psi} = 0, \qquad [\mu]. \end{aligned}$$

The second constraint combines household labor supply with the firm's factor-mix condition. Because $c^f = \chi c^h$ and $u_f/u_h = p$ when $\tau^c = 0$,

$$\frac{d}{dc^h} u(c^h, \chi c^h) = u_h + \chi u_f = \Theta u_h.$$

Let λ and μ denote the multipliers shown in brackets. The resource, factor-demand, and marginal-cost conditions imply

$$\frac{x^f}{\Theta c^h} = \frac{x^f}{GDP}, \qquad (1-\nu)\ell^{-\nu}(x^f)^\nu = \frac{w}{mc}, \qquad \nu \ell^{1-\nu}(x^f)^{\nu-1} = \frac{p(1+\tau^x)}{mc}.$$

The first-order conditions for c^h, ℓ, and x^f can therefore be written, respectively, as

$$u_h = \lambda + \mu \frac{x^f}{\sigma GDP}, \tag{B.5}$$

$$u_h w = \lambda \frac{w}{mc} - \mu(1+\psi)\frac{x^f}{\ell}, \tag{B.6}$$

$$\mu = \lambda p \frac{mc - (1+\tau^x)}{mc}. \tag{B.7}$$

The resource multiplier is nonzero: if $\lambda = 0$, the x^f first-order condition implies $\mu = 0$, contradicting the c^h first-order condition and $u_h > 0$.

Substituting (B.5) into (B.6) and rearranging gives

$$\frac{\mu}{\lambda}\frac{x^f}{\ell}\left(1 + \psi + \frac{w\ell}{\sigma GDP}\right) = -\frac{w}{mc}(mc - 1). \tag{B.8}$$

Finally, substitute (B.7) into (B.8). We obtain

$$(1 + \tau^x - mc)\left(1 + \psi + \frac{w\ell}{\sigma GDP}\right) = \frac{w\ell}{px^f}(mc - 1). \tag{B.9}$$

Solving (B.9) for $mc - 1$ gives

$$mc^{opt} - 1 = \tau^x \frac{1 + \psi + \frac{w\ell}{\sigma GDP}}{1 + \psi + \frac{w\ell}{\sigma GDP} + \frac{w\ell}{px^f}}.$$

where the variables on the right-hand side are evaluated at the Ramsey allocation. At an interior allocation, all the terms in the fraction are strictly positive, so the fraction lies strictly between zero and one. It follows directly that the optimal labor wedge is

$$-\tau^x < \wp^{opt} = -\tau^x \frac{1 + \psi + \frac{w\ell}{\sigma GDP}}{1 + \psi + \frac{w\ell}{\sigma GDP} + \frac{w\ell}{px^f}} < 0.$$

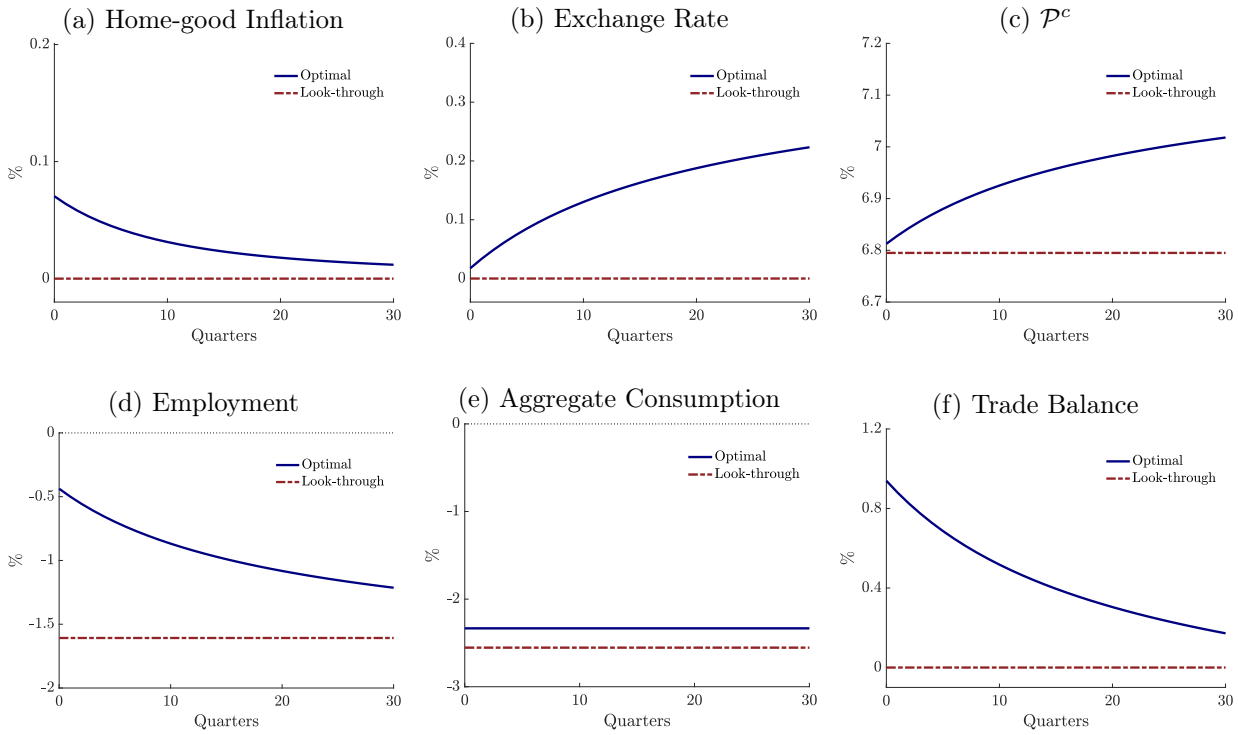
Finally, the stationary Phillips curve satisfies

$$(1 - \beta)(1 + \pi)\pi = \frac{\varepsilon}{\varphi}(mc^{opt} - 1) > 0.$$

Since $1 + \pi > 0$, the implementing inflation rate is positive. Therefore, when $\tau^x > 0$ and $\tau^c = 0$, optimal monetary policy overheats the economy relative to look-through, as in the baseline model.

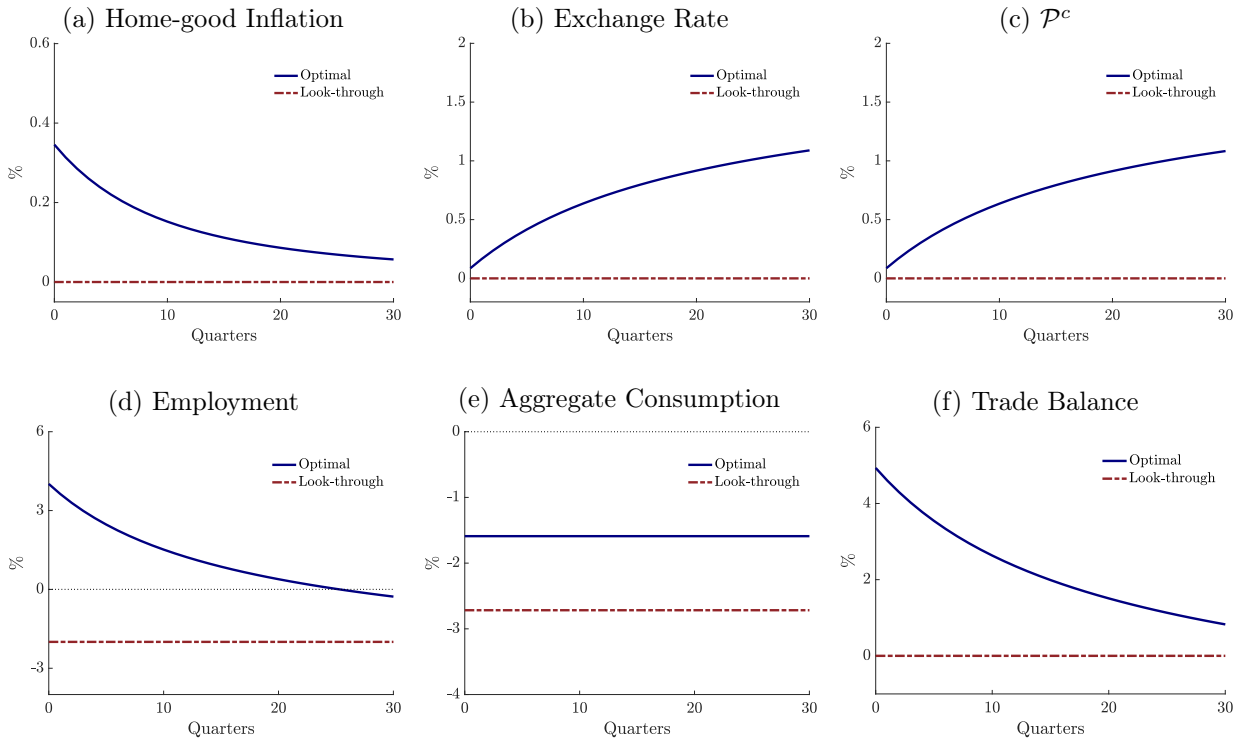
B.3 Simulations

Figure B.1: Tariff on foreign consumption goods in the model with imported inputs



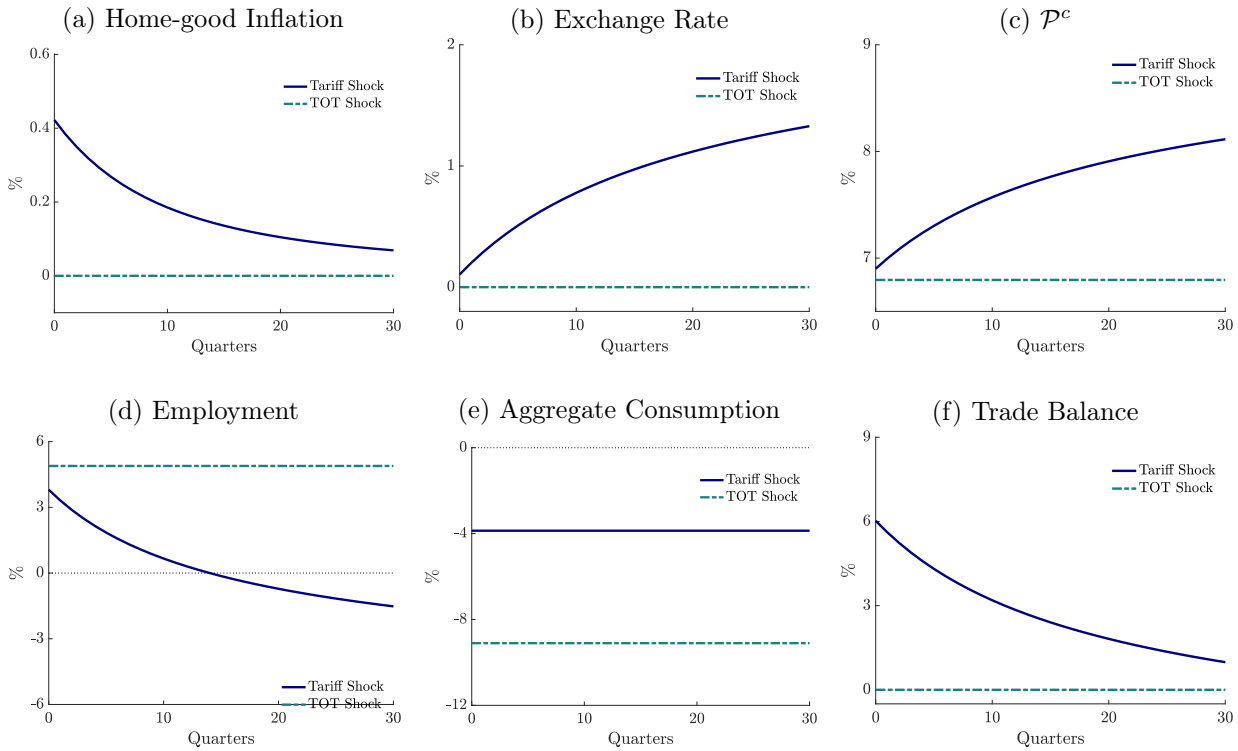
Notes: The tariffs are set to $\tau_t^c = 15\%$ and $\tau_t^x = 0$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure B.2: Tariff on foreign inputs



Notes: The tariffs are set to $\tau_t^x = 15\%$ and $\tau_t^c = 0$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure B.3: Terms-of-trade shocks versus tariffs in the model with imported inputs



Notes: We assume a permanent tariff of $\tau = 15\%$ and a permanent increase in p of 15% in the case of TOT shocks. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

C Extension with Distorted Steady State

C.1 Proof of Proposition 6

Proof. Under a look-through policy (flexible-price allocation), the competitive equilibrium in an economy with a constant tariff and a labor subsidy (32) is given by

$$\ell = c^h + pc^f \tag{C.1}$$

$$c^f = \left(\frac{1-\omega}{\omega p\left(1+\tau\right)}\right)^{\gamma} c^h \tag{C.2}$$

$$\frac{W}{P^h} = \frac{\omega \ell^{\psi}}{u_h\left(c^h, c^f\right)} \tag{C.3}$$

$$P^h = \frac{\varepsilon}{\varepsilon - 1}\left(1-s\right)W \tag{C.4}$$

$$p\tau c^f = s\frac{W}{P^h}\ell \tag{C.5}$$

Using (C.3) and (C.5) to substitute for $\frac{W}{P^h}$ and s, we can rewrite (C.1), (C.2), (C.4) as

$$c^h = \frac{1+\tau}{\Theta_\tau + \tau}\ell \tag{C.6}$$

$$c^f = \frac{\Theta_\tau - 1}{p\left(1+\tau\right)}c^h \tag{C.7}$$

$$\left(\omega\Theta_\tau\right)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}}\left(c^h\right)^{\frac{1}{\sigma}}\left(\ell\right)^{\psi} = \frac{\Theta_\tau - 1}{1+\tau}\frac{\tau c^h}{\ell} + \mathcal{M}^{-1} \tag{C.8}$$

where recall that $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma}\left(p\left(1+\tau\right)\right)^{1-\gamma}$ and where $\mathcal{M} \equiv \frac{\varepsilon}{\varepsilon-1}$ denotes the gross steady-state markup. From (C.8), we obtain that

$$\ell(\tau) = \left[\left(\omega\Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\frac{\Theta_\tau + \tau}{1+\tau}\left(\frac{\Theta_\tau - 1}{\Theta_\tau + \tau}\tau + \mathcal{M}^{-1}\right)^{\sigma}\right]^{\frac{1}{1+\sigma\psi}}$$

and

$$\left.\frac{d\ell(\tau)}{d\tau}\right|_{\tau=0} = \frac{1}{1+\sigma\psi}\frac{\sigma}{\varepsilon-1}\frac{\Theta_0 - 1}{\Theta_0}\ell(0) > 0$$

Using (C.6) and (C.7), we can express welfare as

$$W(\tau) = \frac{1}{1-\beta}\left[\frac{1}{1-\frac{1}{\sigma}}\left(\left(\omega\Theta_\tau\right)^{\frac{\gamma}{\gamma-1}}\frac{1+\tau}{\Theta_\tau+\tau}\right)^{1-\frac{1}{\sigma}}\ell\left(\tau\right)^{1-\frac{1}{\sigma}} - \frac{\omega}{1+\psi}\ell\left(\tau\right)^{1+\psi}\right]$$

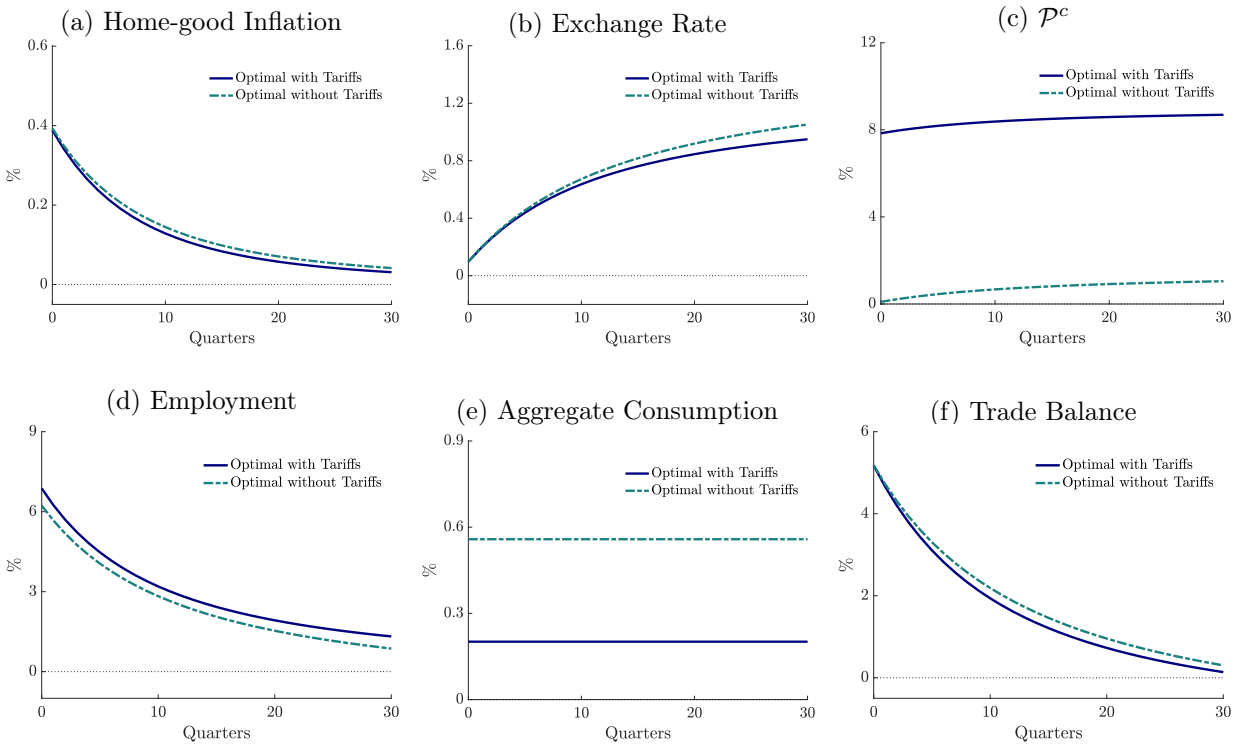
Differentiating (C.1) with respect to τ, we get

$$W'(\tau)\Big|_{\tau=0} = \frac{1}{1-\beta}\frac{\omega}{(\varepsilon-1)^2}\frac{\sigma}{1+\sigma\psi}\frac{\Theta_0-1}{\Theta_0}\ell^{1+\psi} > 0.$$

□

C.2 Simulations with Distorted Steady State

Figure C.1: Distorted steady state



Notes: The figure compares the optimal monetary policy absent tariffs to the optimal monetary policy response to a permanent tariff of $\tau = 15\%$, in both cases starting from a distorted steady state ($s = 0$). The subsidy on labor is given by $P_t^f \tau_t c_t^f = s_t W_t \ell_t$, as in (32). Consumption, employment, the exchange rate and the price level are expressed as percentage deviation from the pre-tariff steady-state allocation with zero inflation.

D Extension with Endogenous Terms of Trade

D.1 Derivation of Equation (33)

We provide here more details on the derivation of the demand function $p_t = A\left(y_t - c_t^h\right)^{\frac{1}{\theta}}$. We consider a world economy composed of a continuum of identical countries indexed by $i \in (0,1)$ and a nested CES structure. Households in any country i have preferences described by

$$\sum_{t=0}^{\infty} \beta^t [U(c_{it}) - v(\ell_{it})]$$

In country i, c_{it} is a CES aggregate of a home good, c_{it}^h, and a foreign-good composite, c_{it}^f. The latter aggregates goods produced in all other countries with elasticity of substitution θ. That is,

$$c_{it} = \left[\omega \left(c_{it}^h\right)^{1-\frac{1}{\gamma}} + (1-\omega)\left(c_{it}^f\right)^{1-\frac{1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \quad \text{and} \quad c_{it}^f = \left(\int_0^1 \left(c_{it}^k\right)^{\frac{\theta-1}{\theta}} dk\right)^{\frac{\theta}{\theta-1}}.$$

The households' budget constraint is given by

$$P_{it}^h c_{it}^h + \int_0^1 P_{it}^k c_{it}^k dk + \frac{B_{i,t+1}}{R_{it}} + \int_0^1 \frac{e_{it}^k b_{i,t+1}^k}{R_t^k} dk = B_{it} + \int_0^1 e_{it}^k b_{it}^k dk + W_{it}\ell_{it} + D_{it},$$

where $B_{i,t+1}$ denotes the holding of domestic-currency bonds, $b_{i,t+1}^k$ the holding of bonds denominated in country k's currency, e_{it}^k is the bilateral nominal exchange rate defined as the price of country k's currency in terms of the domestic currency, and D_{it} denotes firms' profits in country i. The optimality condition for c_{it}^k yields the following demand for good k in country i

$$c_{it}^k = (1-\omega)\left(\frac{P_{it}^k}{P_{it}^f}\right)^{-\theta}\left(\frac{P_{it}^f}{P_{it}}\right)^{-\gamma} c_{it} \tag{D.1}$$

Noting that all foreign countries are symmetric and applying (D.1) to the representative foreign household, we obtain that the demand for the good produced in the SOE by the

representative foreign household is given by

$$c_t^{h*} = (1-\omega)\left(\frac{P_t^{h*}}{P_t^{f*}}\right)^{-\theta}\left(\frac{P_t^{f*}}{P_t^*}\right)^{-\gamma} c_t^* \tag{D.2}$$

Noting that by the law of one price we have $p_t = \frac{P_t^f}{P_t^h} = \frac{P_t^{f*}}{P_t^{h*}}$ and using the fact that $P_t^{f*} = P_t^*$, we can rewrite (D.2) as

$$c_t^{h*} = (1-\omega)\left(p_t\right)^{\theta} c_t^*$$

Finally, using the market-clearing condition for the domestic good in the SOE, that is, $y_t = c_t^h + c_t^{h*}$, we arrive at

$$p_t = \left[(1-\omega)c_t^*\right]^{-\frac{1}{\theta}}\left(y_t - c_t^h\right)^{\frac{1}{\theta}}$$

which corresponds to (33), where $A \equiv \left[(1-\omega)c^*\right]^{-\frac{1}{\theta}}$ is an exogenous demand shifter, with c^* the (constant) level of foreign aggregate consumption.

D.2 Optimal Tariff

The optimal tariff solves

$$\max_{\{c_t^h, c_t^f, \ell_t, \tau_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c_t^h, c_t^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi}\right],$$

subject to

$$0 = \sum_{t=0}^{\infty} \beta^t \left[c_t^h + A\left(\ell_t - c_t^h\right)^{\frac{1}{\theta}} c_t^f - \left(1 - \Upsilon\frac{\varphi}{2}\pi_t^2\right)\ell_t\right], \qquad [\lambda] \tag{D.3}$$

$$c_t^f = \left[\frac{1-\omega}{\omega A\left(\ell_t - c_t^h\right)^{\frac{1}{\theta}}(1+\tau_t)}\right]^{\gamma} c_t^h, \tag{D.4}$$

$$\omega \ell_t^{\psi} = u_h(c_t^h, c_t^f), \tag{D.5}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega\,\ell_t^{\psi}}{u_h(c_t^h, c_t^f)} - 1\right] + \frac{1}{R^*}\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \tag{D.6}$$

where we replace $p_t = A\left(\ell_t - c_t^h\right)^{\frac{1}{\theta}}$ from (33) in the intertemporal budget constraint.

Notice that because τ_t only appears in (D.4), we can infer that this constraint does not

bind. Similarly, we can guess and verify that the last two constraints do not bind. In addition, if the last constraint does not bind, then $\pi_t = 0$ is optimal because it relaxes (D.3) while satisfying (D.6).

The optimality conditions for c_t^f, c_t^h, and ℓ_t are given by

$$u_f(c_t^h, c_t^f) = \lambda p_t \tag{D.7}$$

$$u_h(c_t^h, c_t^f) = \lambda \left(1 - \frac{1}{\theta} \frac{p_t c_t^f}{\ell_t - c_t^h}\right) \tag{D.8}$$

$$\omega \ell_t^\psi = \lambda \left[1 - \frac{1}{\theta} \frac{p_t c_t^f}{\ell_t - c_t^h}\right]$$

where we denote by λ the Lagrange multiplier on (D.3). Note that combining the last two optimality conditions verifies that (D.5) holds at the optimal allocation. From (D.7) and (D.8), we get

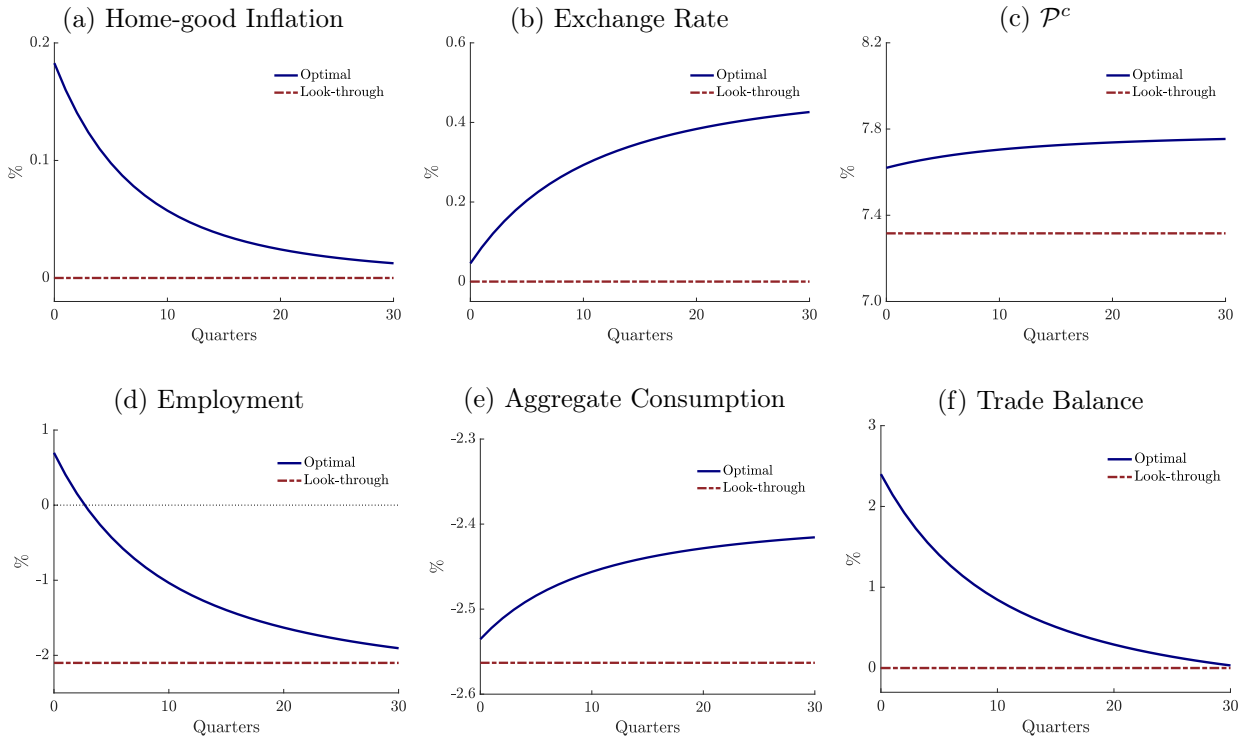
$$p_t \frac{u_h(c_t^h, c_t^f)}{u_f(c_t^h, c_t^f)} = 1 - \frac{1}{\theta} \frac{p_t c_t^f}{\ell_t - c_t^h}$$

Finally, using (D.4) and zero trade balance $p_t c_t^f = \ell_t - c_t^h$, we arrive at

$$\tau_t = \frac{1}{\theta - 1}.$$

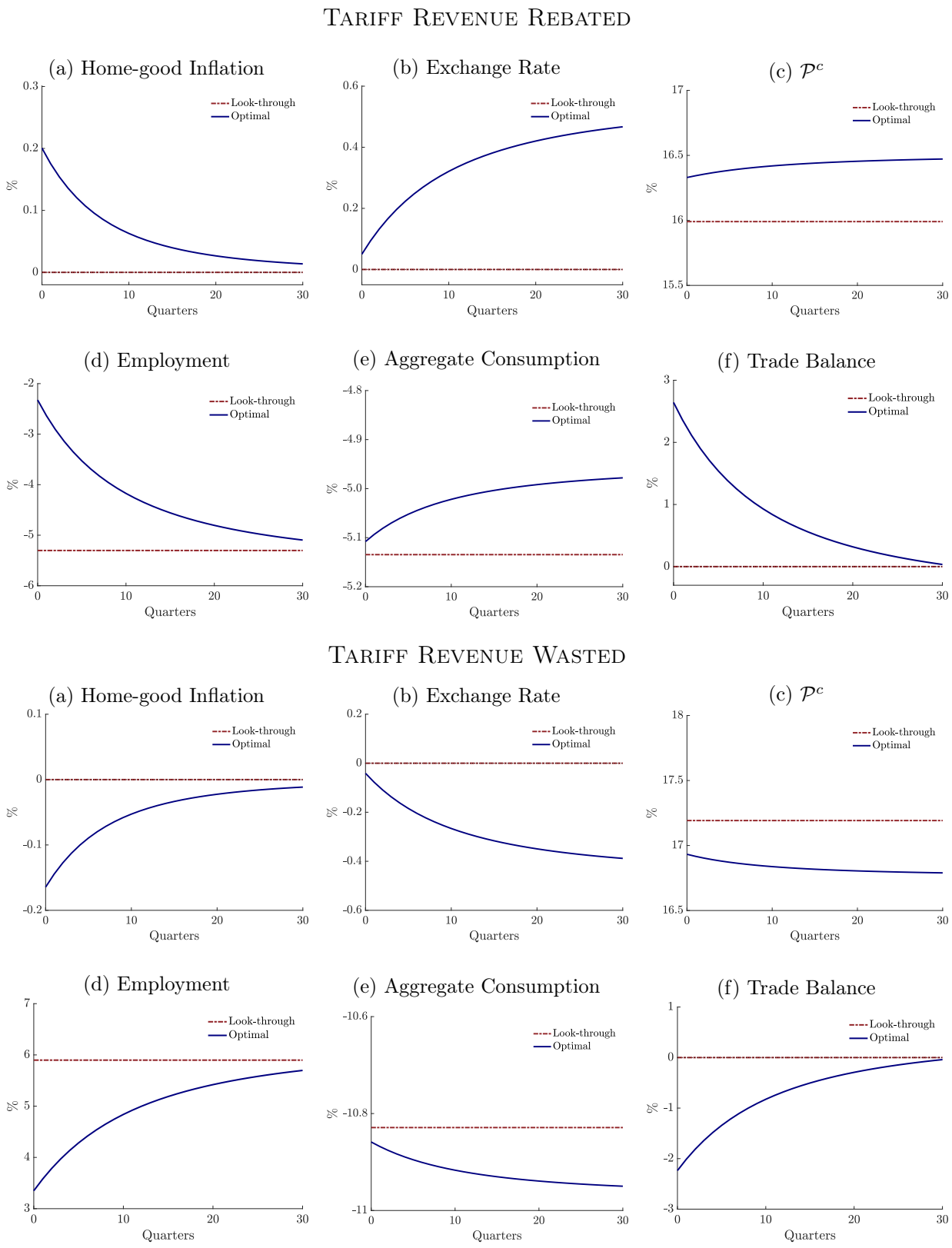
D.3 Simulations with Endogenous Terms of Trade

Figure D.1: Permanent shock to tariffs



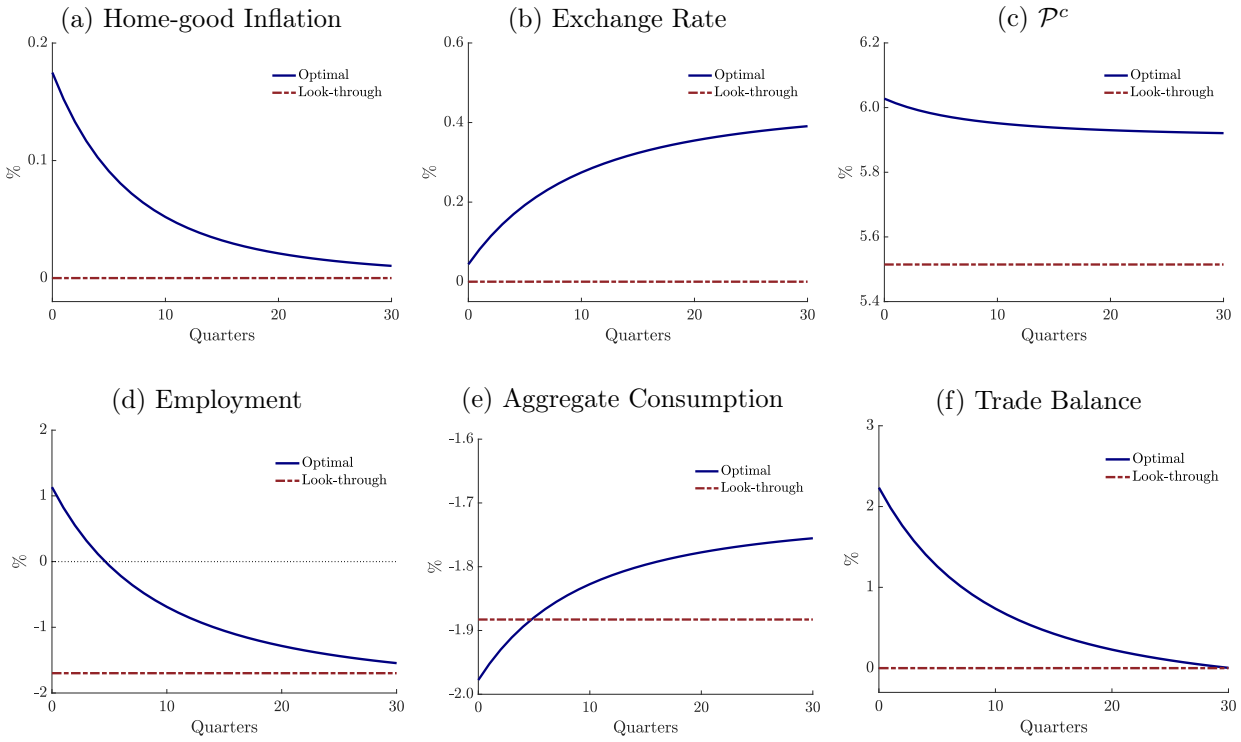
Notes: The figure displays the response to a permanent increase in tariffs of $\Delta\tau = 15\%$ starting from the optimal tariff. The relative price of imports is given by (33) and $\theta = 10$. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate and the tradable price level are expressed as percentage deviation from the allocations before the shock.

Figure D.2: Impulse response to a permanent tariff of 26 percent



Notes: The figure presents the impulse response to a 26% tariff starting from zero tariffs. The relative price of imports is given by (33) and $\theta = 10$. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate and the tradable price level are expressed as percentage deviation from the allocations that would prevail with zero tariffs.

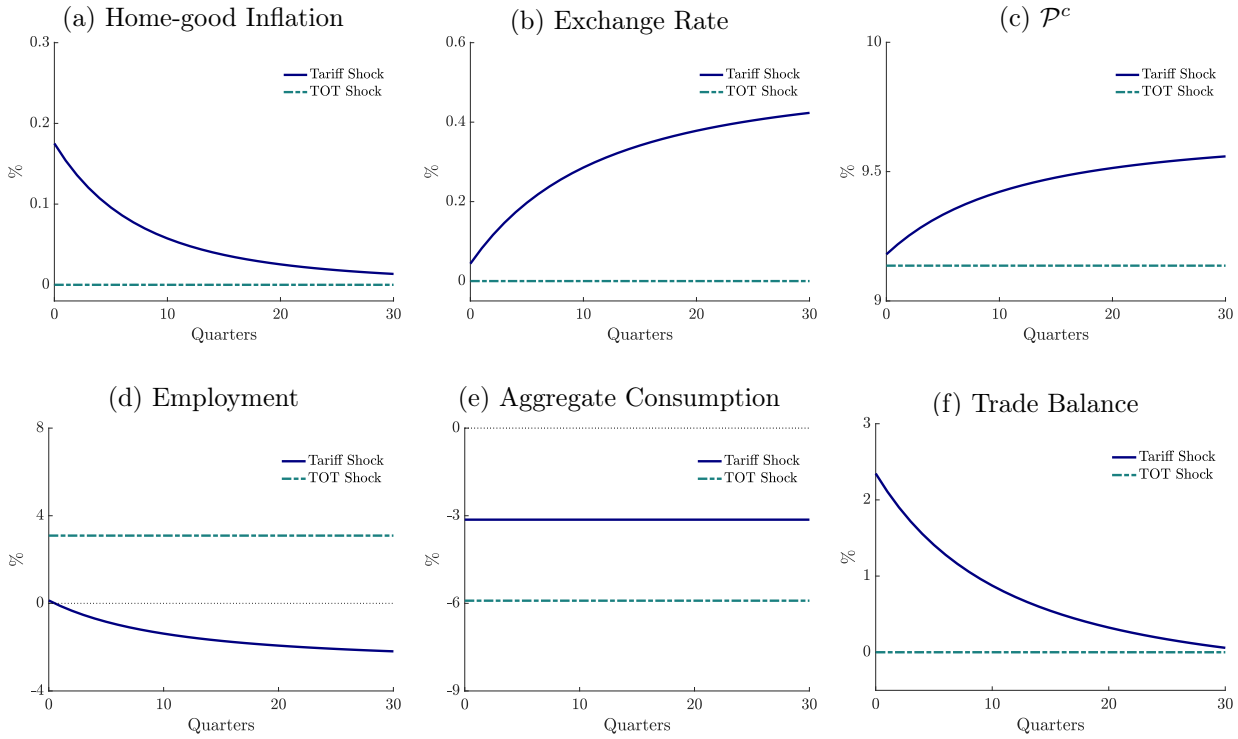
Figure D.3: Sensitivity to export elasticity ($\theta = 5$)



Notes: The figure displays the response to a permanent increase in tariffs of $\Delta\tau = 15\%$ starting from the optimal tariff. The relative price of imports is given by (33) and $\theta = 5$. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate and the tradable price level are expressed as percentage deviation from the allocations before the shock.

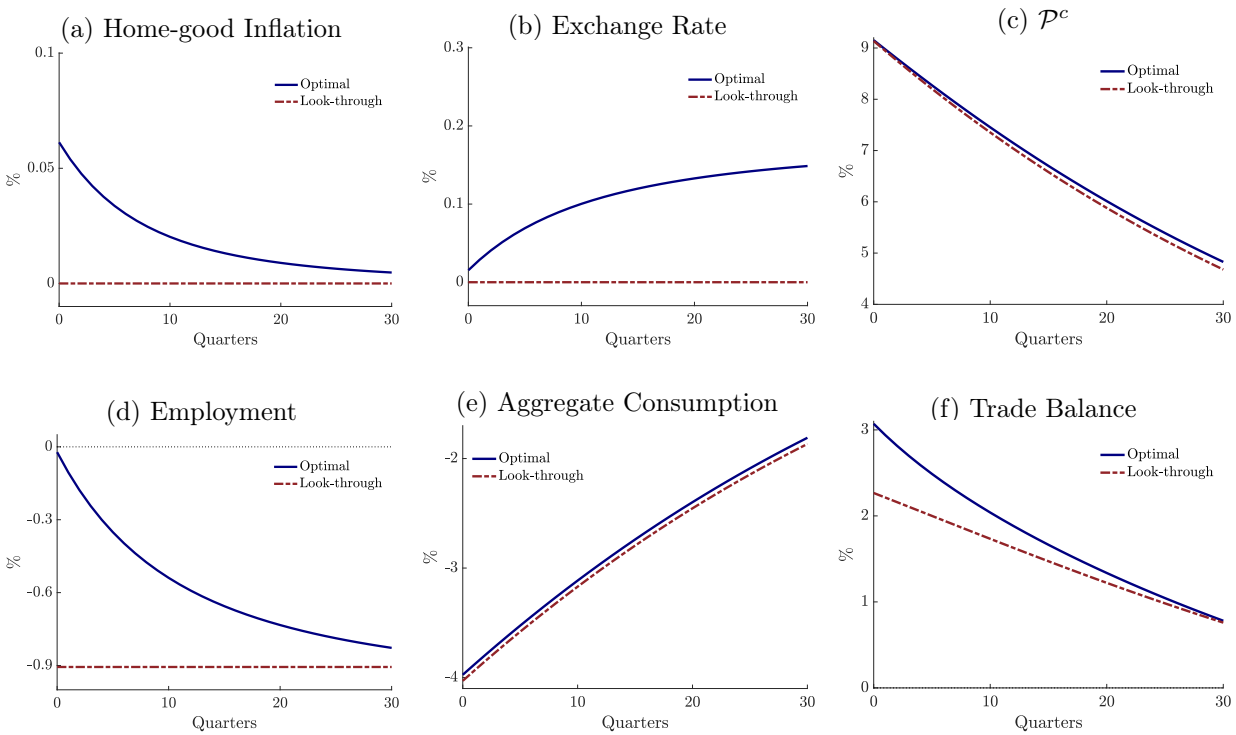
E Additional Figures for Baseline Model

Figure E.1: Tariff shock vs. terms-of-trade shock



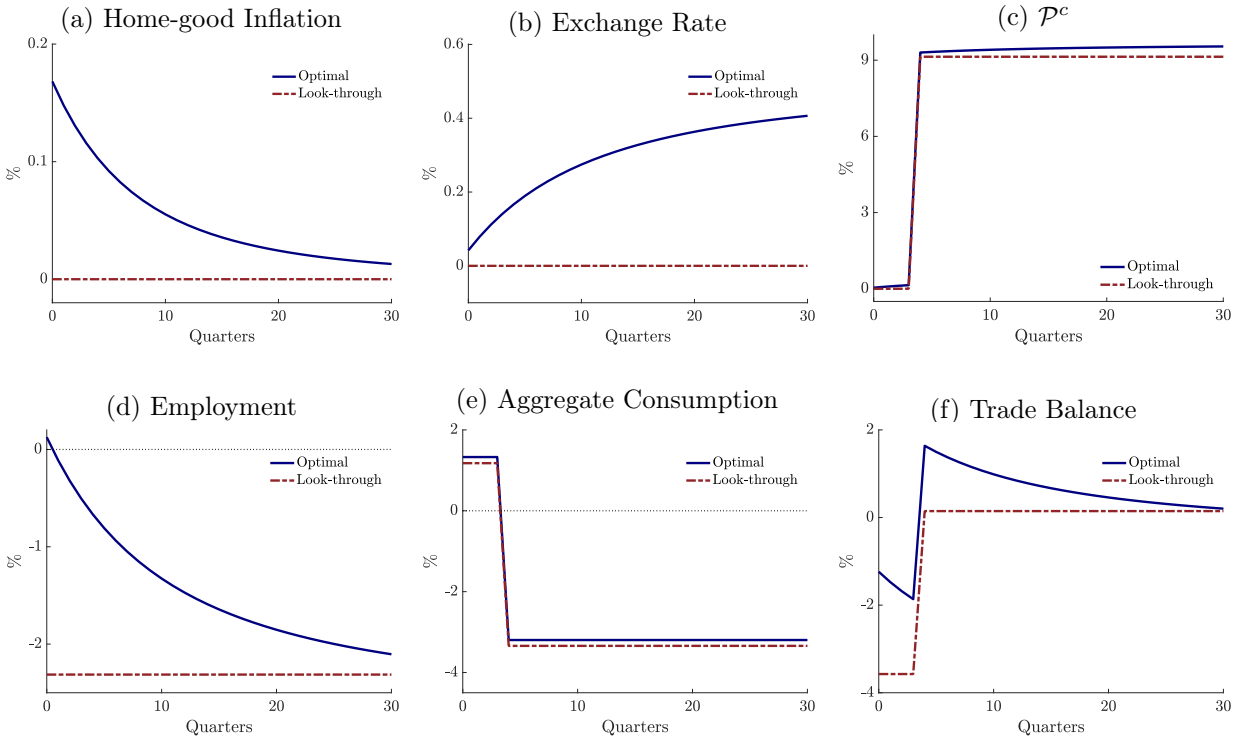
Notes: For the tariff shock, we set a constant tariff $\tau = 15\%$, and for the TOT shock, we assume a permanent 15% increase in p, driven by P^{f*}. In both cases, the simulations correspond to optimal monetary policy. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure E.2: Temporary tariffs



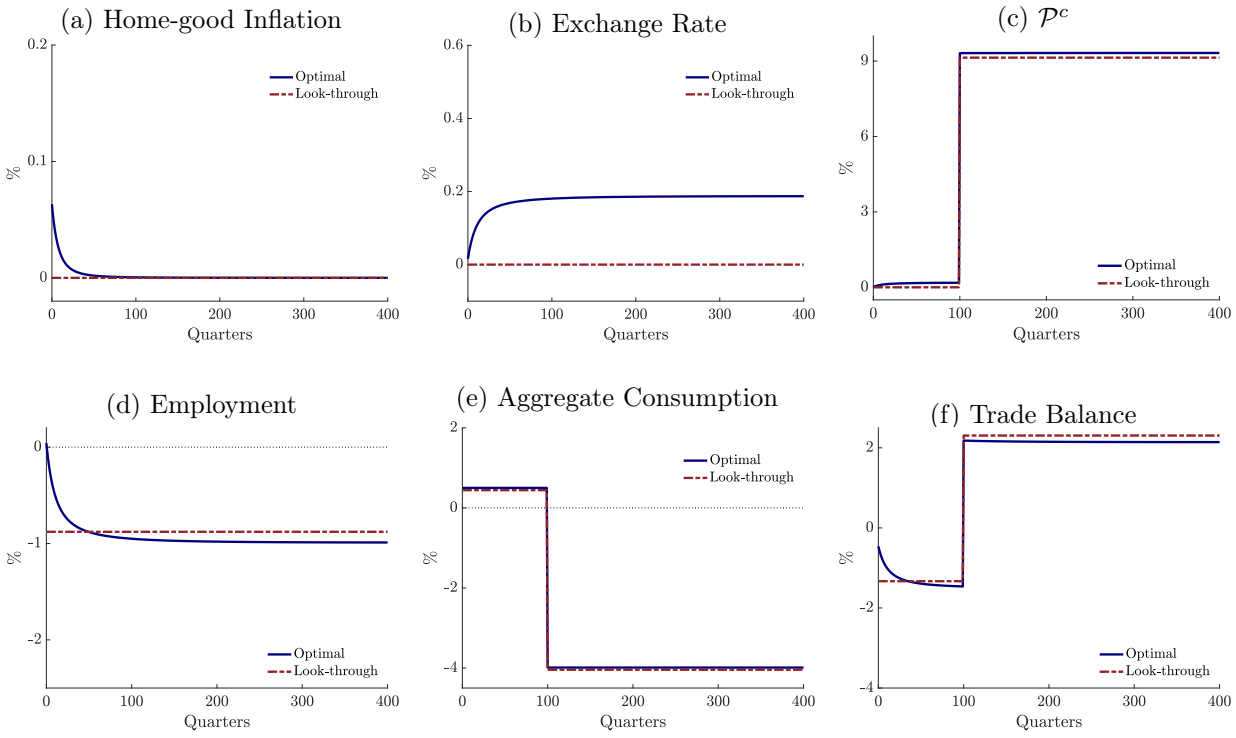
Notes: We assume that the tariff follows $\tau_t = \rho\tau_{t-1}$, with $\tau_0 = 15\%$ and $\rho = 0.976$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure E.3: Anticipated tariffs



Notes: A permanent tariff of 15% is announced at $t = 0$ and imposed at $t = 4$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure E.4: Anticipated tariff implemented at $t = 100$



Notes: A permanent tariff of 15% is announced at $t = 0$ and imposed at $t = 100$. Inflation is annualized. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

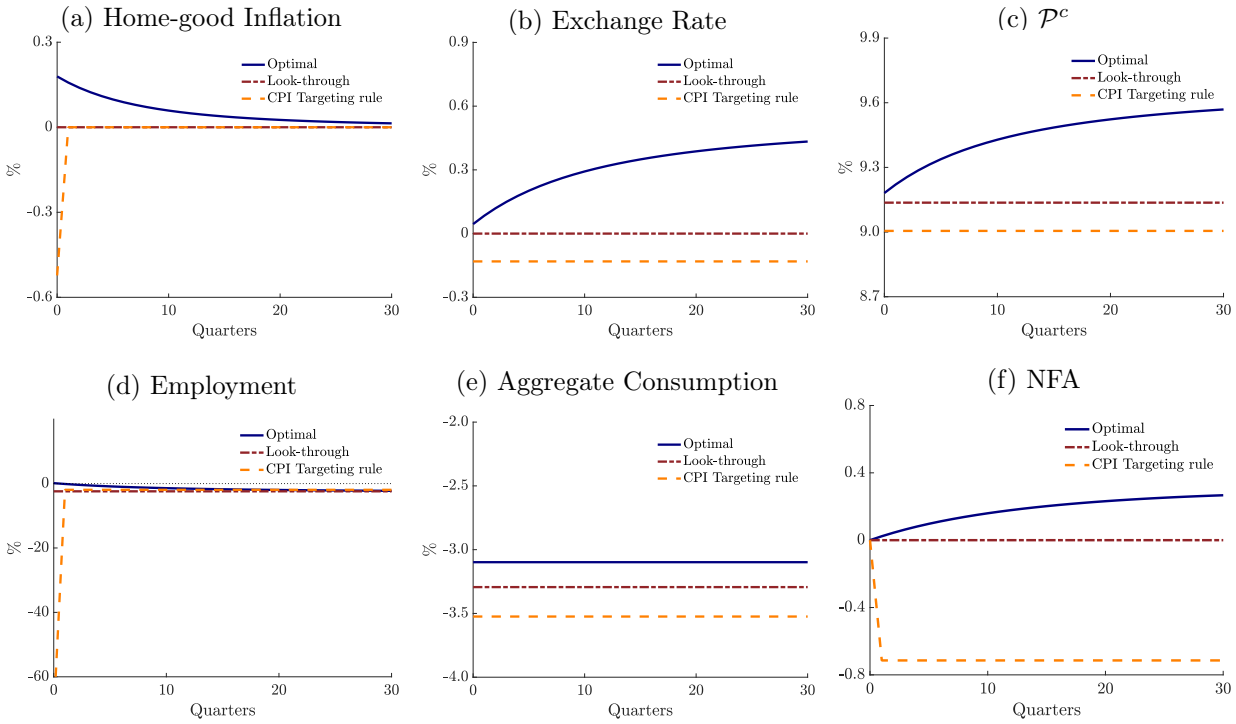
F Simulations under CPI Targeting

Table F.1: Welfare Implications under CPI Targeting

	Gains from Optimal Policy			Losses from Tariffs		
	CPI Targeting rule			CPI Targeting rule		
	$\phi_\pi = 0$	$\phi_\pi = 1.5$	$\phi_\pi = 5$	$\phi_\pi = 0$	$\phi_\pi = 1.5$	$\phi_\pi = 5$
Baseline	0.009	0.26	2.73	1.00	1.25	3.77
Anticipated tariffs	0.008	0.26	0.67	0.97	1.22	1.64
Endogenous TOT	0.007	0.04	0.10	0.69	0.72	0.78
Model with imported inputs						
Tariffs on c and x	0.32	0.61	0.85	1.91	2.21	2.48
Tariffs on c	0.01	0.29	1.00	1.01	1.30	2.02
Tariffs on x	0.22	0.22	0.22	0.80	0.80	0.80

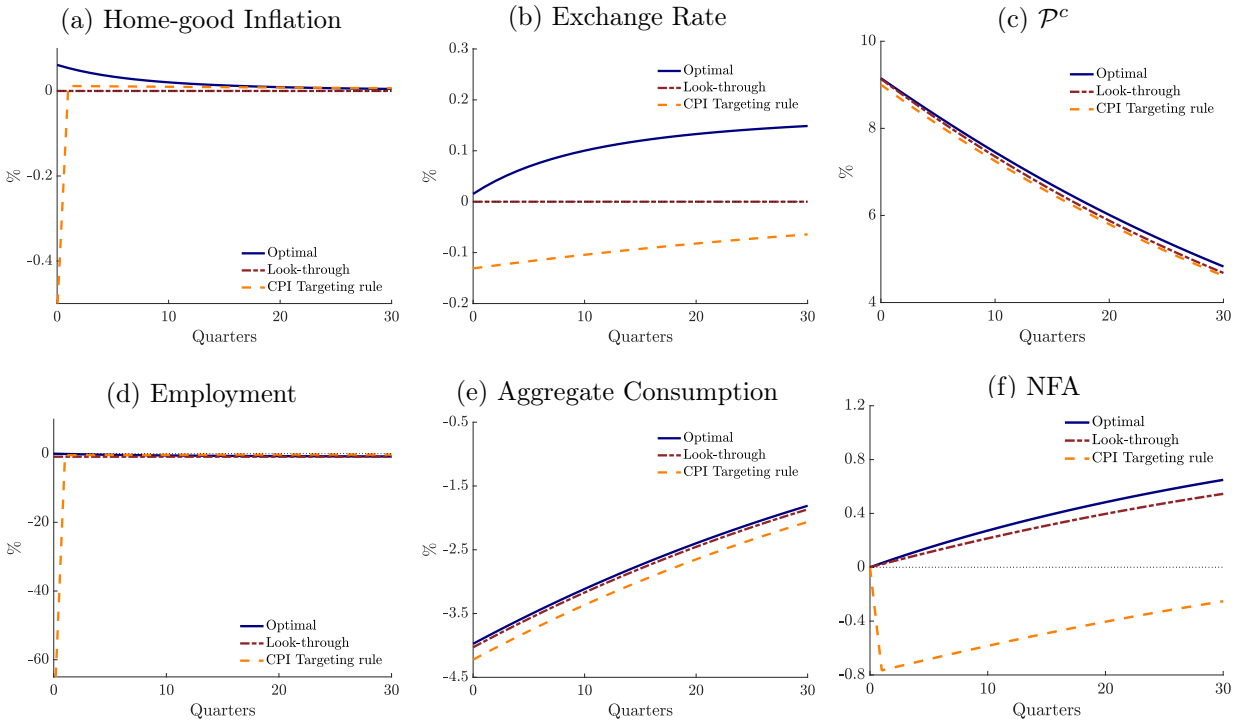
Note: Welfare corresponds to permanent consumption equivalence and is expressed in percent.

Figure F.1: Baseline model with permanent tariff



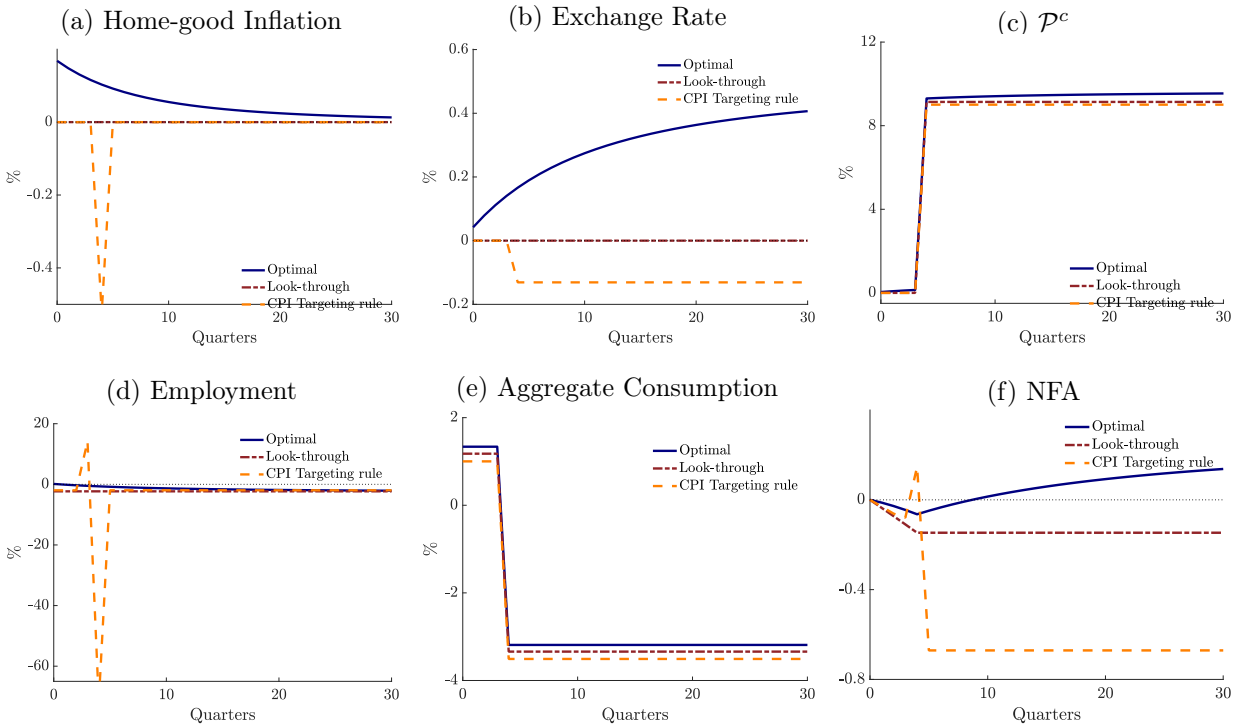
Notes: The tariff is set to $\tau_t = 15\%$ for all t. The CPI targeting corresponds to the targeting rule (35) with coefficient $\phi_\pi = 1.5$. Inflation is annualized. The NFA position is expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure F.2: Baseline model with temporary tariff



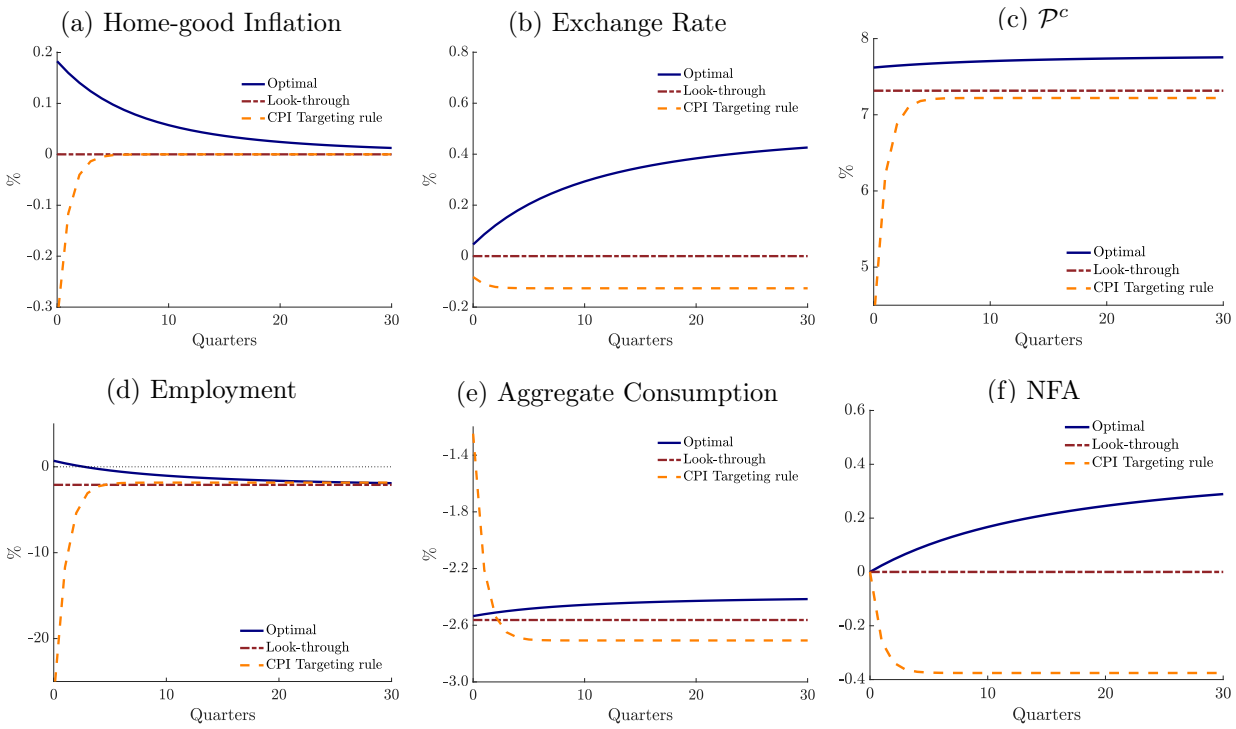
Notes: The tariff follows $\tau_t = \rho\tau_{t-1}$ with $\tau_0 = 15\%$ and $\rho = 0.976$. The CPI targeting corresponds to the targeting rule (35) with coefficient $\phi_\pi = 1.5$. See the note on Figure F.1 for further details.

Figure F.3: Baseline model with anticipated tariff



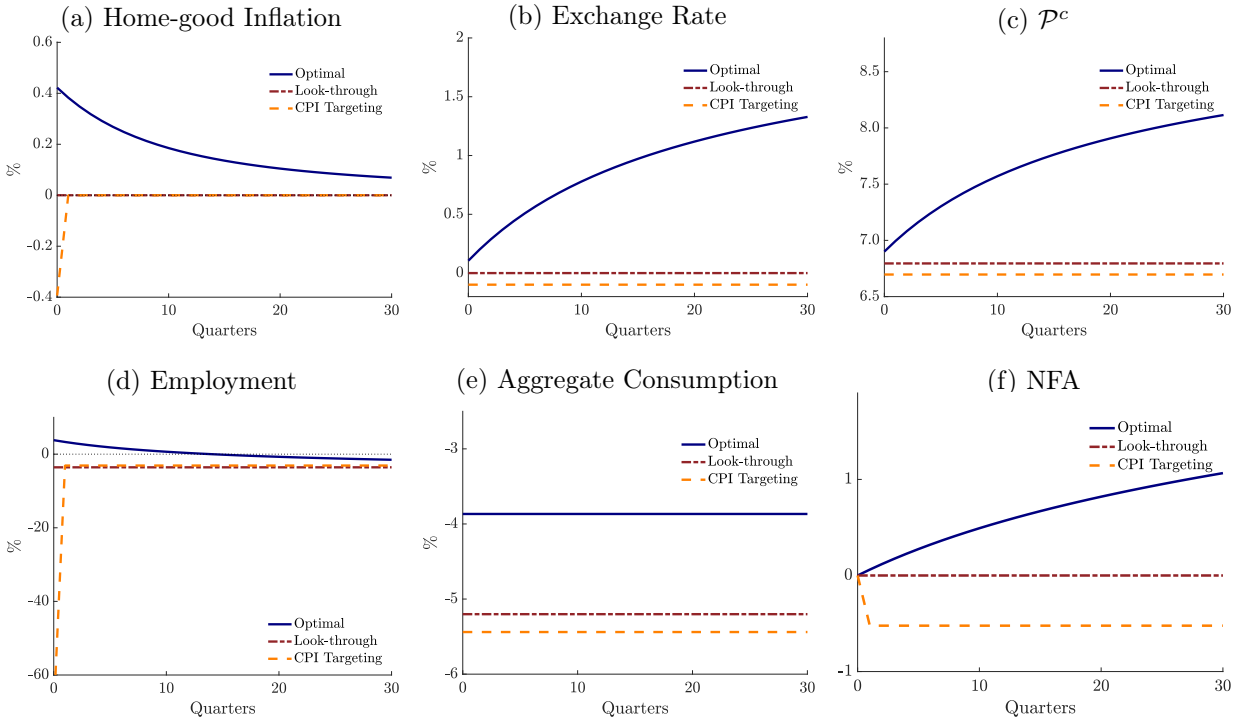
Notes: A permanent tariff of 15% is announced at $t = 0$ and imposed at $t = 4$. The CPI targeting corresponds to the targeting rule (35) with coefficient $\phi_\pi = 1.5$. See the note on Figure F.1 for further details.

Figure F.4: Simulations with endogenous terms of trade



Notes: The figure displays the response to a permanent increase in tariffs of $\Delta\tau = 15\%$, starting from the optimal tariff, when the relative price of imports is given by (33) and $\theta = 10$. The CPI targeting corresponds to the targeting rule (35) with coefficient $\phi_\pi = 1.5$. See the note on Figure F.1 for further details.

Figure F.5: Permanent tariff in the model with imported inputs



Notes: The tariffs are set to $\tau_t^c = 15\%$ and $\tau_t^x = 15\%$. The CPI targeting corresponds to the targeting rule (35) with coefficient $\phi_\pi = 1.5$. See the note on Figure F.1 for further details.