The Optimal Monetary Policy Response to Tariffs*

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Abstract

What is the optimal monetary policy response to tariffs? This paper explores this question within an open-economy New Keynesian model, characterizes the macroeconomic effects of tariffs, and shows that the optimal monetary policy response is expansionary, with inflation rising above and beyond the direct effects of tariffs. This result holds regardless of whether tariffs apply to consumption goods or intermediate inputs, whether the shock is temporary or permanent, and whether terms of trade are exogenous or endogenous. When tariffs address other distortions, monetary policy remains expansionary, but the inflationary effects are mitigated.

Keywords: Tariffs, optimal monetary policy, inflation

JEL Codes: E24, E44, E52, F13, F41

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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]

In this paper, we investigate the optimal monetary policy response to a tariff shock. Contrary to prevailing views, we argue that the optimal monetary policy response is expansionary. The logic is as follows: When a tariff is imposed, private agents perceive the effective cost of importables to be higher than their social cost. This wedge arises because individual agents do not internalize that in equilibrium higher imports raise both tariff revenue and aggregate income. As a result, imports decline more than is socially optimal. Thus, the optimal policy is expansionary, raising employment and aggregate income and mitigating the contraction in imports.

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.

The introduction of tariffs distorts trade by inefficiently reducing imports, as households substitute home goods for foreign goods. In this case, stabilizing inflation does not achieve the efficient allocation—divine coincidence does not hold. We show that the Ramsey-optimal policy overheats the economy, raising inflation and employment above the natural level. The idea is that starting from an allocation with zero inflation and a zero output gap, stimulating the economy entails no first-order costs. However, the monetary stimulus leads to an increase in aggregate income, which

[1]For these opposing views, see remarks by Governor Adriana Kugler, who stated, "It should be a priority to make sure that inflation doesn't move up," and the speech by Governor Chris Waller, 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."

boosts the demand for imports, generating strictly positive first-order gains. This makes it optimal for the monetary authority to tolerate some overheating. Moreover, we show that under some conditions, the monetary authority expands output even above the efficient level.

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; if the tariff is permanent, it leaves the trade surplus 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 an increase in the trade surplus. 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 our theoretical analysis by characterizing the macroeconomic effects of tariffs in the flexible-price allocation, or equivalently, under a monetary policy that targets producer price index (PPI) inflation while allowing a one-time jump in the CPI (a "look-through" policy). We show that, to first order, introducing a tariff reduces employment, though the effect becomes ambiguous for non-marginal changes. Unlike a consumption or labor tax in a one-sector model, tariffs generate two distinct substitution margins: (i) between labor supply and consumption of foreign goods, and (ii) between consumption of home and foreign goods. When home and foreign goods are Hicksian complements—implying that the marginal utility of home goods decreases as imports fall—employment strictly decreases with tariffs. By contrast, when home and foreign goods are Hicksian substitutes—implying that the marginal utility of home goods increases as imports fall—there exists a threshold tariff above which employment increases. For empirically plausible values, tariffs remain contractionary overall under look-through.

We then turn to the analysis of optimal policy. We begin 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 show that the sign of the employment response to a tariff depends 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. Importantly, regardless of the sign of the response, employment under optimal policy is always higher than under look-through. In this sense, tariffs induce the monetary authority to tolerate an overheating economy, with both a positive natural output gap and higher inflation. We stress that this response differs fundamentally from the standard case of a cost-push shock, where the central bank unambiguously contracts output below the efficient level to contain inflation. In contrast, when the IES is below one, optimal policy entails expanding output above the *efficient* level.

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; 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.

Our quantitative simulations indicate that the monetary authority finds it optimal to deviate significantly from PPI targeting. We consider a uniform 15% tariff, following the Trump administration policy. Under look-through, employment falls about 2.4%, while the output gap remains at zero as the monetary authority targets PPI inflation. We also find that under the optimal policy employment rises slightly on impact—but then falls over the long run—and PPI inflation reaches 0.2% (annualized) and gradually returns to target.

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. Short-lived tariffs generate more drastic movements in capital flows while the anticipation of future tariffs leads to a more delicate dilemma for the monetary authority, since an expansionary policy boosts imports inefficiently before the tariff is implemented. Second, we introduce imported intermediate inputs into production. In this case, tariffs distort firms' costs directly, which magnifies the contractionary effects under

PPI targeting and the benefits from stimulative monetary policy, whereby employment rises even more on impact as the monetary authority offsets the higher production costs. Third, we extend the framework to allow for endogenous terms of trade, so that tariffs influence international prices. This channel dampens the required policy response to an inefficient increase in tariffs, but the key quantitative results remain very similar.

We also examine a scenario in which the economy begins from a distorted steady state. Specifically, we consider a setting where the usual subsidy to offset the markup is not in place and tariff revenue is used to subsidize labor. In this case, we find that the optimal policy remains expansionary, while inflation is significantly mitigated. Moreover, we show that tariffs are welfare improving for low tariffs. 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.

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, the recessionary effect of tariffs arises because the nominal exchange rate appreciates, which improves the terms of trade, induces higher saving, and offsets the expenditure-switching effect toward domestic goods (see also Krugman, 1982).

Building on these classic studies, 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] In addition to analyzing optimal policy—our main contribution—we analytically

[2]For early studies of tariffs in an intertemporal macroeconomic framework, see Eichengreen (1981) and Razin and Svensson (1983). 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. (2025) on trade-policy uncertainty; and Lloyd and Marin (2024) on the interaction with capital controls.

characterize when tariffs contract or expand output and how these effects depend on the monetary policy regime. We also show that, even when monetary policy is held constant or the terms of trade are fixed, tariffs affect employment through a labor-supply channel.

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 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, this is the first study to examine the optimal monetary policy from the perspective of a country imposing a unilateral tariff, and to show that the optimal response is expansionary. In addition, our paper articulates why tariff shocks are distinct from standard cost-push or terms-of-trade shocks, as the associated revenue is rebated, generating a fiscal externality.

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 to the foreign consumption good and creates a wedge between the marginal rate of substitution between home and foreign goods and the relative price. This distinction is crucial because as we show, a tariff does

[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."

not operate like a textbook cost-push shock: 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. 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.[4] By contrast, our open economy model features production in a single sector, with a tax that distorts relative consumption across sectors, which, as we show, gives rise to different trade-offs for monetary policy.

Since the first draft of our paper, a fast-growing literature has emerged that analyzes several important macroeconomic aspects of the Trump administration's tariffs. In particular, Monacelli (2025) shows that while temporary export tariffs always reduce employment, import tariffs may either reduce or increase employment depending on the trade elasticity and monetary policy, in a framework in which tariff revenue is not rebated. In addition, Kalemli-Özcan, Soylu and Yildirim (2025) provide a decomposition of the macroeconomic effects of tariff shocks in a multi-sector model with production networks.[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.

[4]A burgeoning literature has incorporated rich sectoral considerations to understand inflation dynamics and optimal monetary policy (see, e.g., 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; La'O and Tahbaz-Salehi, 2022; Rubbo, 2023; Woodford, 2022).

[5]See also Aguiar, Amador and Fitzgerald (2025), Antonova et al. (2025), Bergin and Corsetti (2025), Caliendo, Kortum and Parro (2025), Dávila et al. (2025), Ignatenko et al. (2025), Itskhoki and Mukhin (2025), and Werning, Lorenzoni and Guerrieri (2025). Empirical studies also include Benguria and Saffie (2025), Jiang et al. (2025), Ostry, Lloyd and Corsetti (2025), and Schmitt-Grohé and Uribe (2025).

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

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

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 between 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, $\gamma > 0$ 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 good, 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.[6,7]

[6]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.

[7]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).

We assume that the law of one price holds for both domestic and foreign goods (pre-tariffs). Without loss of generality, both goods have constant prices in foreign currency and the foreign-currency price of the home good is normalized 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, subject to their budget constraint and a no-Ponzi-game condition.[8] 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.

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

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.

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} represents varieties of intermediate inputs, 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 $P_t^h = \left(\int P_{jt}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}$.

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

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

subject to

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

where $\Lambda_{t+1} \equiv \beta \frac{u_h(t+1)}{u_h(t)} \frac{P_t^h}{P_{t+1}^h}$ 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' 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

$$\tau_t P_t^f c_t^f = T_t + s\, P_t^h y_t. \tag{7}$$

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 $\left\{b_{t+1}, c_{t+1}^f, c_{t+1}^h\right\}$ and prices $\left\{P_{t+1}^f, P_{t+1}^h, e_t, W_t\right\}$ 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, $\ell_t = \int_0^1 \ell_{jt}dj$;

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 a balance of payments condition:

$$\underbrace{\left(1-\Upsilon\frac{\varphi}{2}\pi_t^2\right)\ell_t - c_t^h}_{\text{exports}} - \underbrace{pc_t^f}_{\text{imports}} = \underbrace{\frac{b_{t+1}}{R^*} - b_t}_{\text{capital outflows}} . \tag{8}$$

This condition equates the trade surplus 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

$$c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} = b_t + \ell_t. \tag{9}$$

Optimality implies that

$$\frac{v'(\ell_t)}{u_h(c_t^h, c_t^f)} = 1 \tag{10}$$

$$\frac{1-\omega}{\omega}\left(\frac{c_t^h}{c_t^f}\right)^{\frac{1}{\gamma}} = p, \tag{11}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f). \tag{12}$$

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 (11) 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:

$$\max_{\left\{b_{t+1},\pi_t,\ell_t,c_t^f,c_t^h\right\}} \sum_{t=0}^{\infty} \beta^t \left[u(c_t^h, c_t^f) - \omega \frac{\ell_t^{1+\psi}}{1+\psi}\right], \tag{13}$$

subject to

$$c_t^h + p c_t^f + \frac{b_{t+1}}{R^*} = b_t + \left[1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right] \ell_t, \tag{14}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega\, \ell_t^{\psi}}{u_h(c_t^h, c_t^f)} - 1\right] + \frac{1}{R^*}\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \tag{15}$$

$$\frac{1-\omega}{\omega}\left(\frac{c_t^h}{c_t^f}\right)^{\frac{1}{\gamma}} = p(1+\tau_t), \tag{16}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f). \tag{17}$$

Before we analyze the optimal policy problem, we examine a benchmark where the monetary authority targets PPI inflation. We refer to it as "look-through policy:"

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

A policy of targeting PPI inflation is equivalent to implementing the *flexible price allocation*. In relation with current policy discussions on tariffs, the definition we adopt for "look-through" is consistent with the idea of allowing the CPI price level to undergo a one-time jump in response to tariffs, followed by the stabilization of inflation thereafter (see Waller, 2025b).

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* (13) *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 (14)-(17), we arrive at the conditions characterizing the efficient allocation, (9)-(12). □

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: (9), (10), and (12) are satisfied, but comparing (11) and (16) 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 back 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.

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 (13), with $\Upsilon = 0$ we have that π_t appears only in the Phillips curve, and thus we can drop constraint (15) 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 $\psi > 0$ imply that labor is constant.

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

$$\max_{c^h, c^f, \ell} \; u(c^h, c^f) - \omega \frac{\ell^{1+\psi}}{1+\psi} \tag{18}$$

$$\text{subject to}$$

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

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

This formulation highlights that, when $\Upsilon = 0$, optimal monetary policy can be reformulated as *the planner choosing labor on behalf of households, while households determine the mix of consumption.*

The proposition below establishes that the level of employment is strictly higher under optimal policy than under look-through.

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

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

$$\ell_t^{opt}(\tau) = \left(\frac{1+\tau}{1+\Theta_\tau^{-1}\tau}\right)^{\frac{\sigma}{1+\sigma\psi}} \left[\frac{\Theta_\tau + \tau}{1+\tau} \left(\omega \Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}} \geq \ell_t^{look}(\tau). \tag{20}$$

where we define $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^\gamma (p(1+\tau))^{1-\gamma} > 1$*. The inequality in* (20) *is strict whenever* $\tau > 0$*.*

In addition, the levels of consumption are given by

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

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 depress inefficiently the level of imports, the monetary authority overheats the economy to reduce the inefficient decline in imports.[9] The proposition also highlights 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 consumption 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 start by considering first the response of employment under a look-through policy. This case is a useful benchmark, since look-through replicates the flexible-price allocation in the absence of tariffs. 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*

$$\frac{d\log \ell^{look}}{d\tau} = -\frac{(\Theta_\tau - 1)}{(1+\sigma\psi)(1+\tau)(\Theta_\tau+\tau)\Theta_\tau}\left[\sigma\Theta_\tau + (\sigma-\gamma)\tau\right] \tag{21}$$

[9] 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.

The key takeaway is that tariffs may be contractionary or expansionary under look-through. The first term in (21) 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 textbook one-sector model, a consumption tax is equivalent to a tax on labor supply—it 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 substitution effects. First, a tariff reduces the real wage in terms of foreign goods, discouraging labor supply. Second, depending on the sign of $\sigma - \gamma$, tariffs can lead to a lower or higher marginal utility of home goods. When home and foreign goods are Hicksian complements (i.e., $u_{hf} > 0$, $\sigma > \gamma$), a fall in foreign consumption lowers the marginal utility of home goods, inducing households to work less. Conversely, when goods are Hicksian substitutes (i.e., $u_{hf} < 0$, $\sigma < \gamma$), a fall in foreign consumption raises the marginal utility of home goods, inducing households to work more to acquire them—with this force strengthening as tariffs increase. Evaluating (21) at $\tau = 0$ shows that a marginal tariff always reduces employment under look-through. Starting from the efficient allocation, the shift in expenditures toward home goods necessarily lowers the marginal utility, and hence this decline translates directly into lower employment.

As discussed in the introduction, the idea that tariffs can be contractionary on employment has a long precedent, starting from Mundell (1961). In the early static models, the contractionary effect on employment emerged because of the appreciation of the exchange rate and a rise of saving following the Harberger-Laursen-Metzler effect. Here, by contrast, the contraction occurs without movements in the exchange rate or the terms of trade.[10]

Optimal policy. Let us turn now to analyze the effects of employment under the optimal policy. 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*

$$\frac{d\log \ell^{opt}}{d\tau} = \frac{(\Theta_\tau - 1)}{(1+\sigma\psi)(1+\tau)(\Theta_\tau+\tau)\Theta_\tau}(1-\sigma)\gamma\tau \tag{22}$$

Starting from zero tariffs, a marginal 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 (implying that the economy reduces both exports and imports).

Three lessons emerge from the analysis. First, divine coincidence does not hold in the presence of tariffs. While the PPI inflation targeting implements the natural level of output, it does not coincide with the efficient level. Second, under optimal policy, output may be below or above the efficient level—however, it always induces a higher level of output compared to look-through policy. Third, when $\sigma < 1$, a tariff shock differs sharply from a textbook cost-push shock. In response to a cost-push shock, optimal policy yields a level of output above the natural level but still below the efficient one. By contrast, a tariff shock can lift output above both.

3.3 Inspecting the Mechanism

In this section, we delve deeper into why the monetary authority chooses to stimulate the economy in response to tariffs, and why a tariff is different from a TOT shock and

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

a cost-push shock.

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 $\mathcal{W}$ subject to (16). The first-order condition yields

$$0 = \frac{\partial \boldsymbol{L}}{\partial c^f}\underbrace{\left[1 - \frac{\omega \ell^\psi}{u_h(c^h, c^f)}\right]}_{\text{labor wedge}} + \underbrace{\frac{\partial \boldsymbol{T}}{\partial c^f}}_{\text{fiscal externality}} \tag{23}$$

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.[11]

Tariffs vs. TOT 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 (13) faces the following intertemporal budget

[11]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 in a public good. In the latter case, households fail to internalize that higher imports would increase the funding for the public good.

constraint

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c^h + p(1+\tau)c^f - \left(1 - \frac{\varphi}{2}\pi_t^2\right) \ell_t \right] \tag{24}$$

An important observation is that this budget constraint is identical to a situation where a terms-of-trade (TOT) shock changes the international price of imports to $p(1+\tau)$. It follows from (24) that *a tariff where the 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 $T_t = 0$ and that Assumption 1 holds. Then, under the optimal monetary policy, the level of employment and consumption are respectively given by*

$$\ell_t^{\diamond}(\tau) = \left[\Theta_\tau \left(\omega\Theta_\tau\right)^{\frac{\sigma-\gamma}{\gamma-1}}\right]^{\frac{1}{1+\sigma\psi}}, \quad c_t^h(\tau) = \frac{1}{\Theta_\tau}\ell_t^{\diamond}(\tau), \quad c_t^f(\tau) = \frac{\Theta_\tau - 1}{p(1+\tau)\Theta_\tau}\ell_t^{\diamond}(\tau), \tag{25}$$

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 p or in τ. 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.

Comparing (25) 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, when tariff revenue is not rebated, employment is higher than under the look-through policy in our baseline model. This result is intuitive, because rebating tariff revenue creates a wealth effect that raises nonlabor income and reduces labor supply, lowering employment under look-through. By contrast, under the optimal policy, employment can be lower or higher than in the no-rebate case, depending on the balance between the stimulative effect of monetary expansion and the contractionary wealth effect.

Tariff vs. cost-push shocks. In a recent paper, Werning, Lorenzoni and Guerrieri (2025) argue that a tariff shock is isomorphic to a textbook cost-push shock—such as an increase in firms' market power. Under the assumptions of balanced trade and an intertemporal elasticity of substitution equal to one, they show that the loss function can be reduced to minimizing a weighted sum of squared inflation and squared deviations of output from its efficient level. In this formulation, a tariff shock leads the monetary authority to trade off the inflationary costs against the gains from raising output toward the efficient level, as in the case of a textbook cost-push shock.

Our results in Corollary 2 show that when the intertemporal elasticity of substitution $\sigma < 1$, a tariff shock implies a fundamental departure from the textbook cost-push shock. Whereas in the textbook case the optimal policy raises output above the natural level but keeps it below the efficient level, in our model the monetary authority expands output beyond both. This stark difference arises from the fiscal externality created by the tariff: to prevent an inefficient contraction in imports, it becomes optimal to stimulate employment even beyond the efficient benchmark.

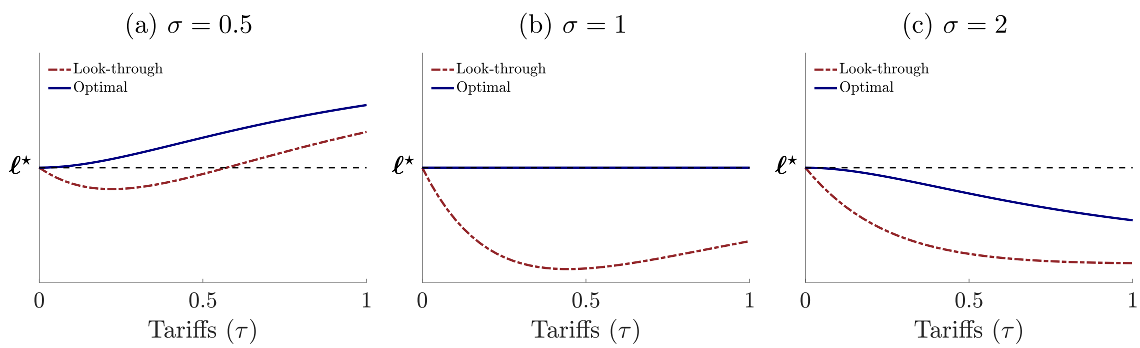

Figure 1: Output as a function of tariffs.

Notes: Parameters: $\gamma = 4$, $\omega = 0.5$ and $\psi = 0$. The dashed line represents the efficient level of employment $\ell^\star$. Inflation is annualized. The trade balance and the NFA position are 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.

To illustrate, Figure 1 plots employment as a function of tariffs for three values of σ (Proposition 2). The solid blue line is the optimal policy, the red dashed line is look-through, and the gray dotted line is the efficient level. For $\sigma = 1$, employment under the optimal policy is invariant to tariffs, while employment under look-through lies strictly below the efficient benchmark. For $\sigma = 2$, employment declines with tariffs, and it declines more under look-through. Most importantly, for $\sigma = 0.5$, employment under the optimal policy increases with tariffs—thus, exceeding the efficient level. Note that there exists a tariff level at which natural and efficient employment coincide (PPI inflation is zero). Yet, the fiscal externality makes it optimal for the monetary authority to stimulate output beyond the efficient level.

3.4 General Case ($\Upsilon > 0$)

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.[12]

Let us set $\Upsilon = 1$ and maintain the assumptions that $\beta R^* = 1$ and $\tau_t = \tau$. Under these assumptions, we have that (16) and (17) imply that c_t^f and c_t^h are still constant. Iterating forward on the country budget constraint (8), we can write the problem as

$$\max_{\{c^h, c^f, \ell_t, \pi_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c^h, c^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right], \tag{26}$$

subject to

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c^h + p c^f - \left(1 - \frac{\varphi}{2}\pi_t^2\right) \ell_t \right], \qquad [\lambda] \tag{27}$$

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

$$c^f \leq \left[\frac{1-\omega}{\omega p (1+\tau)} \right]^{\gamma} c^h, \qquad [\xi] \tag{29}$$

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

with Lagrange multipliers in brackets. While the implementability constraint (29) holds with equality at the optimum, we express it as an inequality to make it 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 (28) (i.e., reducing π_t in period t).

Optimality with respect to c^h yields

$$u_h(c^h, c^f) + \frac{c^f}{c^h}\xi = \lambda + \frac{\gamma + \sigma(\Theta_\tau - 1)}{\gamma\sigma\Theta_\tau}\frac{\varepsilon}{\varphi}\sum_{t=0}^{\infty}(1-\beta)\beta^t \frac{\omega\ell_t^\psi}{c^h u_h(c^h, c^f)}\eta_t, \tag{30}$$

Condition (30) 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 (29). That is, 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 (28).

Optimality with respect to c^f yields:

$$u_f(c^h, c^f) - \xi = \lambda p - \frac{(\sigma - \gamma)(\Theta_\tau - 1)}{\gamma\sigma\Theta_\tau}\frac{\varepsilon}{\varphi}\sum_{t=0}^{\infty}(1-\beta)\beta^t \frac{\omega\ell_t^\psi}{c^f u_h(c^h, c^f)}\eta_t, \tag{31}$$

Relative to the previous first-order condition, we can see now that an increase in c^f tightens (29). Combining (30) and (31), 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 (29), 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

$$\omega\ell_t^\psi + \frac{\varepsilon}{\varphi}\left[(\psi+1)\frac{\omega\ell_t^\psi}{u_h(c^h, c^f)} - 1\right]\frac{\eta_t}{\ell_t} + (1+\pi_t)\pi_t\left(\frac{\eta_{t-1}}{\ell_{t-1}} - \frac{\eta_t}{\ell_t}\right) = \left(1 - \frac{\varphi}{2}\pi_t^2\right)\lambda, \tag{32}$$

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 $\{\pi_t\}$:

$$\frac{\pi_t}{1+2\pi_t} = \frac{1}{\varphi\lambda}\left(\frac{\eta_t}{\ell_t} - \frac{\eta_{t-1}}{\ell_{t-1}}\right), \quad \text{for } t > 0, \tag{33}$$

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

$$\frac{\pi_0}{1+2\pi_0} = \frac{\eta_0}{\varphi\lambda\ell_0}. \tag{34}$$

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

We note that $1 + 2\pi_0 > 0$.[13] Condition (34) 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 for $\Upsilon > 0$)**.** *Assume that $\beta R^* = 1$, $\tau_t = \tau > 0$ and $\psi \to 0^+$. Then, under optimal monetary policy, the labor wedge is approximately given 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

[13] 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 $\pi_0 < 0$ 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.

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.

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 positive effects of tariffs and the normative implications for monetary policy.

4 Quantitative Analysis

4.1 Calibration

We calibrate the model to the US economy at a quarterly frequency and solve it using a global non-linear algorithm.[14] 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 $\omega = 0.42$. 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.

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

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

4, which lies within the empirical range (see Boehm, Levchenko and Pandalai-Nayar, 2023; Caliendo and Parro, 2022).

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	0.42
ε	Elasticity of substitution (varieties)	6
φ	Price-adjustment cost	$3,272$

4.2 Baseline Results

We assume throughout that the economy is initially at a steady state where $b_0 = 0$ and no tariffs. We first study the optimal response to a permanent increase in tariffs. For each experiment, we will present the simulation path for the relevant macroeconomic variables. We report home-good inflation annualized 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 $\mathcal{P}_t^c = \left[P_t^h \left(\omega^\gamma + (1-\omega)^\gamma (p(1+\tau_t))^{1-\gamma}\right)^{\frac{1}{1-\gamma}}\right]$.

Figure 2 presents the simulations in response to a permanent tariff of $\tau = 15\%$, in line with recent measures of the Trump administration.[15] We compare the optimal policy (blue solid) with the "look-through" policy (red dashed). 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

[15]The original "Liberation Day" set minimum tariffs of 10% and higher tariffs for several countries. For several countries, the hike in tariff was postponed or withheld; we examine below the anticipation effects of a tariff policy that is expected to be enacted in the future.

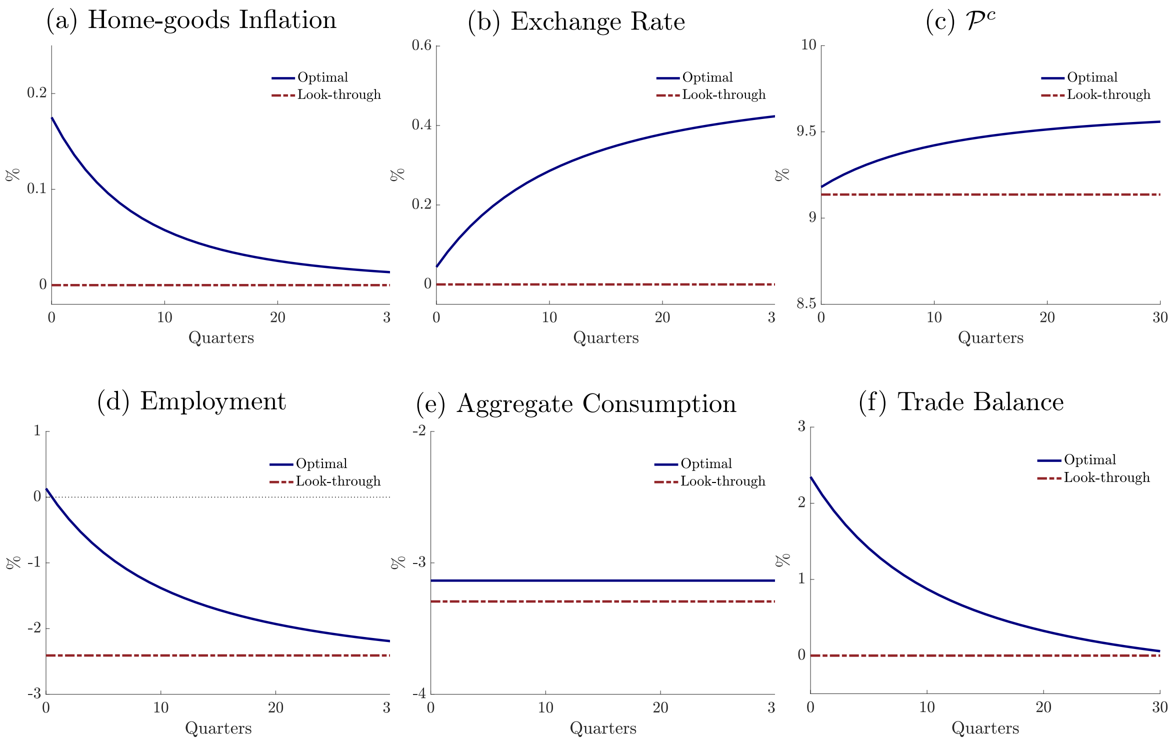

Figure 2: Baseline response to a permanent tariff

Notes: The tariff is set to $\tau_t = 15\%$ for all t. Inflation is annualized. The trade balance and the NFA position are 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.

depress labor supply. Finally, aggregate consumption is permanently lower (panel e), consistent with the contractionary effect of tariffs.

Under the optimal policy, inflation and the exchange rate rise in the short-run (panels a and b) as the monetary authority seeks to stimulate employment and aggregate income above the flexible-price allocation. In fact, employment rises slightly. Over time, inflation falls and converges to zero. The long-run allocation corresponds to the flexible-price allocation characterized by zero inflation (panel a). The accumulation of trade surplus resulting from the monetary policy stimulus raises the NFA position and, hence, long-run consumption above pre-tariff levels. The result that a permanent tariff increases trade surplus contrasts with standard neutrality results (Razin and

Svensson, 1983).[16]

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 4 years. Figure F.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 market 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.

4.4 Shock to Future Tariffs

We study an announced tariff (news shock): the measure is announced at date 0, implemented at date 4, and then held constant. Figure F.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 argue that the anticipation of tariffs generates a more delicate trade-off for the monetary authority. Like before, stimulating the economy at $t = 0$ helps to raise aggregate income and overall consumption. However, we also have now an inefficient increase in imports before the tariff hike takes place. As a result, the monetary authority implements an expansionary monetary policy, bthough less aggressive than under an unanticipated tariff.

[16] Recent work highlights other mechanisms by 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.

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 $y_{jt} = \ell_{jt}^{1-\nu} x_{jt}^{\nu}$, and the country's budget constraint becomes

$$c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} = b_t + \left(1 - \frac{\varphi}{2}\pi_t^2\right) y_t - p_t x_t^f, \tag{35}$$

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 C). Mirroring our baseline model, tariffs induce firms to perceive an inefficiently high cost of imports, which the monetary authority counteracts by stimulating the economy.[17]

Figure 3 presents the results of a permanent tariff that applies to both consumption goods and inputs.[18] We calibrate the output elasticity with respect to imported inputs to match that half of imports corresponds to intermediate inputs, which results in $\nu = 0.35$ (and recalibrate ω to continue to match the import share). Under the look-through policy, GDP (defined as $y_t - px_t$) falls more than in the baseline (-3.5% 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 effect leads to an increase in employment (panel b) and GDP expands on impact by 3.6% while it contracts -4.3% under the 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

[17] See Appendix C.2 for analytical derivations under $\Upsilon = 0$.

[18] Figures C.1 and C.2 present cases where tariffs apply only to consumption goods or intermediate inputs.

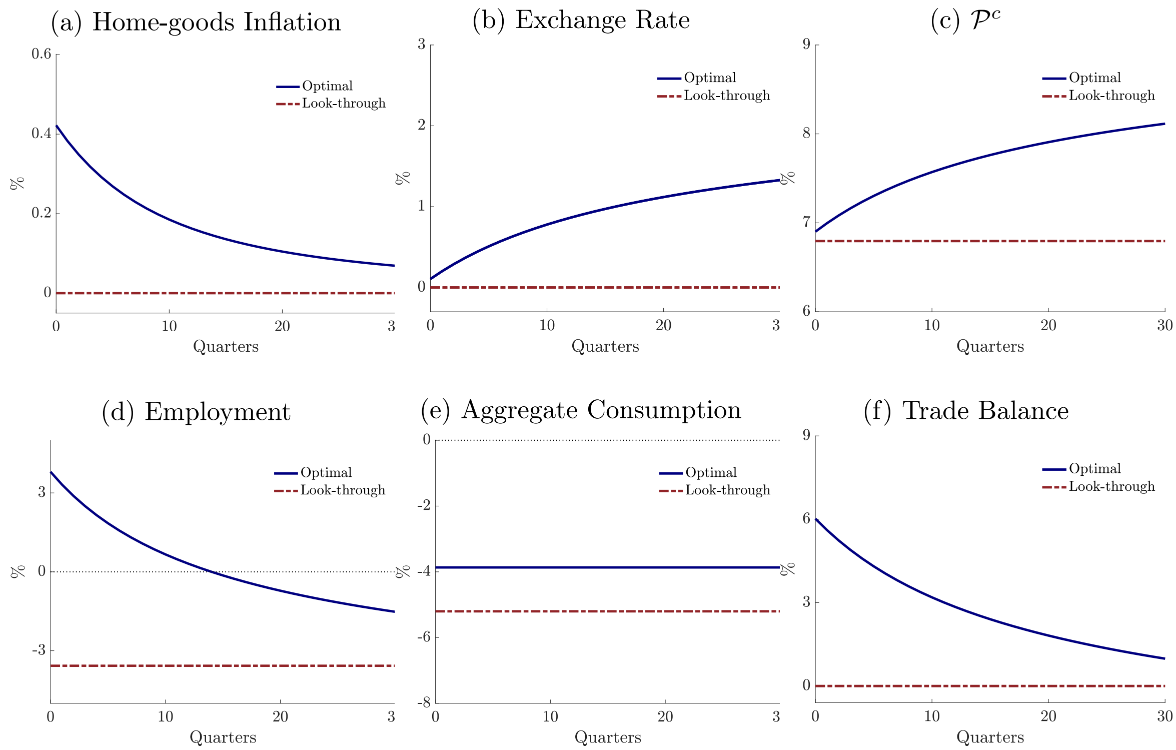

Figure 3: Response to a tariff shock in the model with imported inputs.

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 and the NFA position are 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.

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 C.1 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 C.3). In other words, divine coincidence holds in our model for TOT shocks to imported inputs.[19] 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 labor 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

$$P_t^f \tau_t c_t^f = s_t W_t \ell_t \tag{36}$$

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 (a), 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

[19] 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.

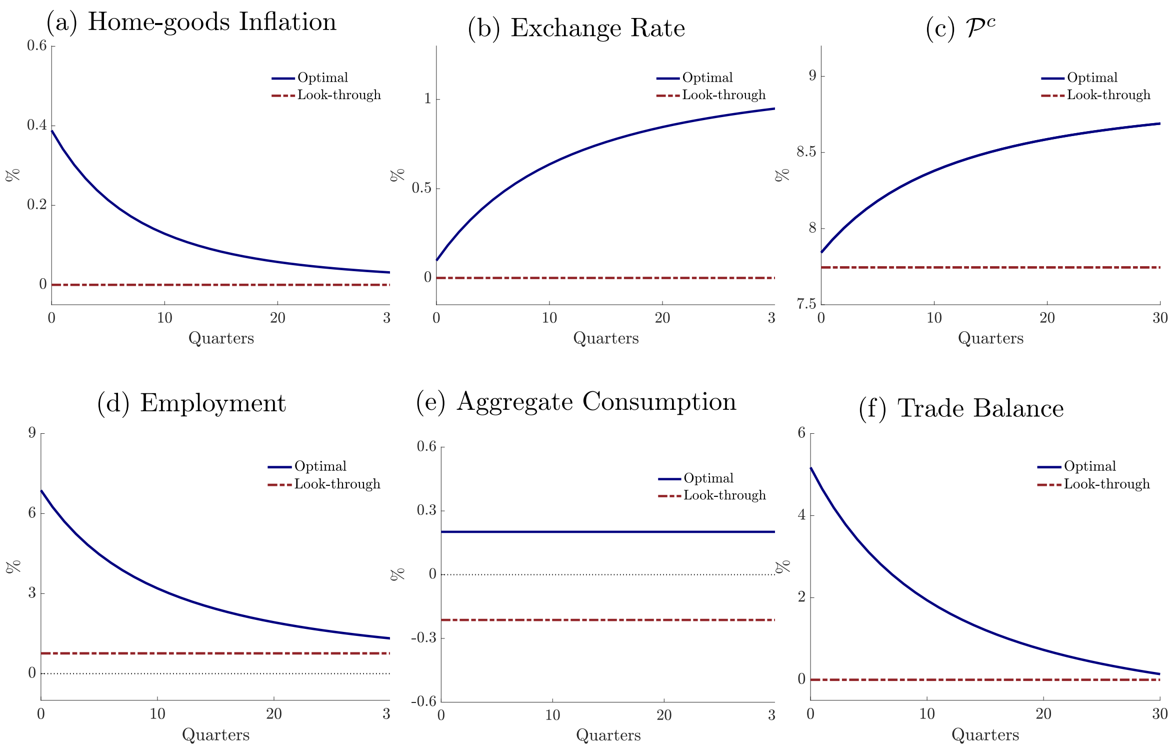

Figure 4: Response to a permanent tariff shock of 15% with a distorted steady state

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 percent deviation from the pre-tariff allocation.

leads to a significant increase in employment and a rise in inflation. However, much of the rise in inflation reflects the pre-existing distortion in the steady state. In fact, the increase in labor subsidy is a deflationary force, and thus inflation is about the same with and without tariffs (see Figure D.1)

5.3 Endogenous Terms of Trade

In our baseline model, the relative price of home and foreign goods is exogenous. The assumption enables us to abstract from a terms-of-trade manipulation incentive 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

$$p_t = A\left(y_t - c_t^h\right)^{\frac{1}{\theta}}, \tag{37}$$

where A captures the overall global demand for domestic goods and θ represents the export demand elasticity. (See Appendix E.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 E.2, starting from $b_0 = 0$, the optimal policy for the small open economy implies the following tariff

$$\tau_t^\star = \frac{1}{\theta - 1}. \tag{38}$$

and a zero PPI inflation.[20]

The proposition below shows that, starting from this efficient tariff, the optimal monetary policy is expansionary in response to a tariff increase—just as in the baseline model.

Proposition 5 (Optimal policy under endogenous TOT)**.** *Assume that $\beta R^* = 1$, $\Upsilon = 0$, $\tau_t = \tau^\star + \Delta\tau$. Then, the labor wedge ($\wp$) under the optimal policy is given by*

$$\wp_t = -\left[1 + \frac{\theta - 1 + \gamma}{\theta}\frac{c^h}{pc^f}\right]^{-1}\frac{\Delta\tau}{1 + \tau^o} \tag{39}$$

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.[21] Figure E.1 shows the optimal response to a 15% tariff shock,

[20] 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 $b_0 = 0$. Itskhoki and Mukhin (2025) shows how the optimal tariff depends on initial currency portfolio positions.

[21] 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 E.3 presents simulations with a lower θ.

implying an increase of 15 percentage points above the optimal level ($\tau^\star = 11.1\%$). As in our baseline model 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.[22]

The key takeaway is that, whether terms of trade are exogenous or endogenous, the optimal response to an inefficient tariff increase is to stimulate the economy, since households do not internalize that higher imports raise tariff revenue and aggregate income.

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.

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

[22] 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, note that a tariff shock with wasted revenue acts as an exogenous downward shift in export demand (37), effectively rescaling A to $A/(1+\tau)$. 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 E.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.

Table 2: Welfare Implications

	Gains 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 w/ 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 percentage.

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* (36)*, 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.[23] 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

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

wedge financed by tariff revenue more than offsets the tariff's distortion.[24]

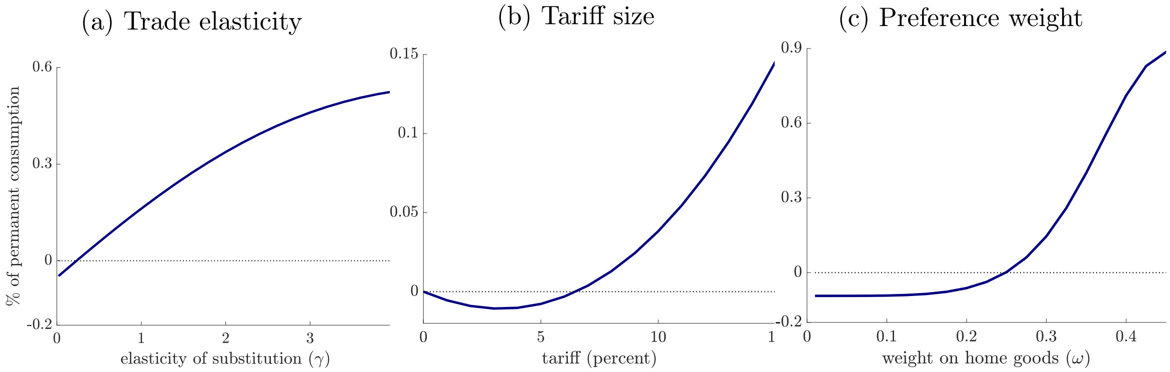

Figure 5: Welfare loss from tariffs under optimal policy when steady state is distorted

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 in the x-axis, all parameters are set to their baseline values.

5.5 CPI Targeting

We adopted 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

$$R_t = \bar{R}_t \left(\frac{\mathcal{P}_t^c}{\mathcal{P}_{t-1}^c} \right)^{\phi_\pi}, \quad \text{with} \quad \bar{R}_t \equiv R^* \frac{e_{t+1}}{\bar{e}_t}, \tag{40}$$

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

Appendix G presents simulations comparing the optimal policy with CPI targeting at $\phi_\pi = 1.5$. As the figures show, CPI targeting requires a monetary tightening, leading to worse macroeconomic outcomes relative to look-through. Moreover, the

[24] 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 et al. (2025) explore how fiscal reforms that include tariffs on imports can raise welfare by reducing reliance on labor and capital taxes.

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 tariffs on the rest of the world. Contrary to prevailing policy views, we show that the optimal policy is expansionary, leading to a positive output gap, an exchange rate depreciation, and an increase in inflation beyond the direct effects of tariffs on imported goods. The logic is that tariffs create a fiscal externality by inefficiently reducing private incentives to import foreign goods, and monetary policy should stimulate aggregate income to counteract this distortion.

Our result on 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. Our analysis also highlights that tariffs can either expand or contract employment, but that optimal policy always raises employment relative to a look-through policy. Moreover, we show that 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 mitigated and welfare can improve for small tariffs.

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.

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Appendix

A Proof of Proposition 2

Proof. Using the functional form for u and c, and (16), 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 in (17) and using $\beta R^* = 1$, we arrive at $c_t^h = c_{t+1}^h$ for all t, and from (16), it follows that c_t^f is also constant.

Replacing these expressions in (14)-(17), and using $\pi_t = 0$ for all t, we obtain

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

which yields the expressions in the proposition.

Under the optimal policy, the Ramsey planner (18) can be rewritten as

$$\begin{aligned}
&\max_{c^h,\ell} \frac{(\omega\Theta_\tau)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}}}{1-\sigma^{-1}}\left(c^h\right)^{1-\frac{1}{\sigma}} - \omega\frac{\ell^{1+\psi}}{1+\psi} \qquad \text{(A.2)} \\
&\text{subject to} \quad \frac{\Theta_\tau+\tau}{1+\tau}c^h = \ell,
\end{aligned}$$

The solution to this problem is

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

which are the expressions for optimal policy in the proposition. In addition, given that $\Theta_\tau > 1$, we have that $\frac{1+\tau}{1+\Theta_\tau^{-1}\tau} > 1$, and thus the result that $\ell^{opt} \geq \ell^{look}$, with equality if $\tau > 0$ follows.

Finally, we use (16), (A.1), and a constant level of inflation $\pi_t = \pi$, and obtain

$$
\begin{aligned}
(1+\pi)\pi &= \frac{\varepsilon}{\varphi} \sum_{t=0}^{\infty} \beta^t \left[(\omega \Theta_\tau)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi} - 1 \right] \\
&= \frac{\varepsilon}{\varphi(1-\beta)} \frac{(\Theta_\tau - 1)\,\tau}{\Theta_\tau + \tau} > 0 \qquad \text{(A.3)}
\end{aligned}
$$

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

A.1 Proof of Corollaries 1 and 2

Proof. Corollary 1 follows directly from differentiating (19) with respect to τ, and Corollary 2 follows from differentiating (20) with respect to τ.

□

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

Javier Bianchi and Louphou Coulibaly

B Proofs

B.1 Proof of Proposition 3

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

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

subject to

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

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

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c^h + p(1+\tau)c^f - \left(1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right)\ell_t \right], \qquad [\lambda] \tag{B.4}$$

It is immediate that the implementability constraints are the same if the TOT is given by $p(1+\tau)$ and tariffs are zero. Therefore, for any monetary authority's policy, allocations are the same.

To solve the Ramsey problem, we guess and verify that only the last constraint binds. The allocation then solves

$$\omega \ell^{\psi} = u_h(c^h, c^f) \iff \ell^{\psi} = (\omega \Theta_\tau)^{\frac{\sigma-\gamma}{\sigma(\gamma-1)}} \left(c^h\right)^{-\frac{1}{\sigma}} \tag{B.5}$$

$$\ell = c^h + p(1+\tau)c^f \iff \ell = \Theta_\tau c^h \tag{B.6}$$

$$c^f = \left[\frac{1-\omega}{\omega p(1+\tau)}\right]^{\gamma} c^h \iff c^f = \frac{\Theta_\tau - 1}{p(1+\tau)} c^h, \tag{B.7}$$

which yield (25). Note from (B.5) and (B.2) that $\pi_t = 0$ for all t. □

B.2 Proof of Proposition 4

Proof. The solution to the Ramsey optimal policy problem is given by (27), (28), (30)-(34). Using (28) and (33), we rewrite (32) as

$$\omega = \left[1 - \frac{1}{1+2\pi_t}\frac{\varphi}{2}\pi_t^2 + \left(\beta\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1} - (1+\pi_t)\pi_t\right)\frac{\eta_t}{\ell_t}\right]\lambda. \tag{B.8}$$

Combining (30) and (31), we get

$$\lambda = \Xi\frac{\Theta_\tau(1+\tau)}{\Theta_\tau+\tau}u_h\left(c^h, c^f\right) \tag{B.9}$$

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 (33) we have

$$\frac{\eta_t}{\ell_t} = \varphi\lambda\sum_{k=0}^{t}\frac{\pi_k}{1+2\pi_k}. \tag{B.10}$$

A first-order approximation of (B.8) and Ξ around $\pi_t = 0$ yields $\lambda = \omega$ and $\Xi = 1$. Replacing these in (B.9) we arrive at

$$\omega = \frac{\Theta_\tau(1+\tau)}{\Theta_\tau+\tau}u_h\left(c_t^h, c_t^f\right) \tag{B.11}$$

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

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

$\square$

B.3 Proof of Proposition 5

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

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

$$\text{s.t.} \quad c^f = \left(\ell - c^h\right)^{-\frac{\gamma}{\theta}} \left(\frac{1-\omega}{\omega A(1+\tau)}\right)^{\gamma} c^h \tag{B.12}$$

$$\ell = c^h + A(\ell - c^h)^{\frac{1}{\theta}} c^f \tag{B.13}$$

Denoting by ξ and λ the Lagrange multipliers on (B.12) and (B.13), the first order conditions for c^f, c^h and ℓ are given by

$$u_f(c_t^h, c_t^f) - \xi = \lambda p_t \tag{B.14}$$

$$u_h(c^h, c^f) + \left[\frac{c^f}{c^h} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\right]\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{B.15}$$

$$\omega\left(\ell\right)^{\psi} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{B.16}$$

Combining (B.15) and (B.16), we obtain

$$1 - \frac{\omega\left(\ell\right)^{\psi}}{u_h(c^h, c^f)} = -\frac{c^f}{c^h u_h(c^h, c^f)}\xi \tag{B.17}$$

Note that the left hand side of (B.17) is the labor wedge $\wp \equiv 1 - \frac{\omega \ell^{\psi}}{u_h(c^h, c^f)}$. Next, combining (B.14) and (B.15) and using (B.13), we get

$$\xi = \left[\tau - \frac{1}{\theta}(1+\tau)\right]\left[\frac{\theta - 1}{\theta} + \frac{pc^f}{c^h} + \frac{\gamma}{\theta}\right]^{-1} u_h(c^h, c^f)$$

$$= \frac{\Delta\tau}{1+\tau^\star}\left[\frac{\theta - 1 + \gamma}{\theta} + \frac{pc^f}{c^h}\right]^{-1} u_h\left(c^h, c^f\right) \tag{B.18}$$

where we used $\tau = \tau^\star + \Delta\tau$ with $\tau^\star \equiv \frac{1}{\theta - 1}$. Plugging (B.18) into (B.17), we arrive at

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

□

C Extension with Imported Inputs

C.1 Analytical Derivations

The household problem is identical to 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 producer firm produces a variety j out of labor ℓ_{jt} and intermediate inputs x_{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, we assume now a subsidy on production, instead of the wage bill. 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

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

The government budget constraint satisfies

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

Combining (C.1) and (C.2) with the households' budget constraint, we arrive to (35).

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

$$\max_{\{b_{t+1},\pi_t,\ell_t,x_t^f,c_t^f,c_t^h\}} \sum_{t=0}^{\infty} \beta^t \left[u(c_t^h, c_t^f) - \omega \frac{\ell_t^{1+\psi}}{1+\psi}\right], \tag{C.3}$$

subject to

$$c_t^h + pc_t^f + \frac{b_{t+1}}{R^*} = b_t + \left[1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right] \; y_t - px_t^f$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\left(\frac{\omega \ell_t^{\psi}}{(1-\nu)u_h(c_t^h, c_t^f)}\right)^{1-\nu} \left(\frac{p(1+\tau_t^x)}{\nu}\right)^{\nu} - 1\right] + \frac{1}{R^*}\frac{y_{t+1}}{y_t}(1+\pi_{t+1})\pi_{t+1},$$

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

$$p(1+\tau_t^x)x_t^f = \frac{\nu}{1-\nu}\frac{\omega \ell_t^{\psi+1}}{u_h(c_t^h, c_t^f)}$$

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

$$y_t = (\ell_t)^{1-\nu}(x_t^f)^{\nu}$$

C.2 The Case with $\Upsilon = 0$

We first show an analogous result to the baseline that states that for a marginal increase in tariffs, GDP falls under look-through.

Under look-through, the equilibrium conditions can be summarized by

$$c^h + pc^f = \ell^{1-\nu}\left(x^f\right)^{\nu} - px^f \tag{C.4}$$

$$c^f = \left(\frac{1-\omega}{\omega p}\right)^{\gamma} c^h, \tag{C.5}$$

$$p(1+\tau^x)x^f = \frac{\nu}{1-\nu}\frac{\omega \ell^{\psi+1}}{u_h(c^h, c^f)} \tag{C.6}$$

$$1 = \left(\frac{\omega \ell^{\psi}}{(1-\nu)u_h(c^h, c^f)}\right)^{1-\nu} \left(\frac{p(1+\tau^x)}{\nu}\right)^{\nu} \tag{C.7}$$

Combining (C.6) and (C.7), we obtain

$$x^f = \left(\frac{\nu}{p(1+\tau^x)}\right)^{\frac{1}{1-\nu}} \ell \tag{C.8}$$

Next, substituting (C.8) and (C.5) into (C.4) we obtain

$$\Theta c^h = \frac{1-\nu+\tau^x}{1+\tau^x} \left(\frac{\nu}{p(1+\tau^x)}\right)^{\frac{\nu}{1-\nu}} \ell \tag{C.9}$$

where we define $\Theta \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma} p^{1-\gamma}$. Finally, substituting (C.5) and (C.9) into (C.7), we arrive at

$$\ell = \left[\Theta \left(\omega\Theta\right)^{\frac{\sigma-\gamma}{\gamma-1}} (1-\nu)^{\sigma} \left(\frac{\nu}{p(1+\tau^x)}\right)^{\frac{(\sigma-1)\nu}{1-\nu}} \frac{1+\tau^x}{1-\nu+\tau^x}\right]^{\frac{1}{1-\nu}} \tag{C.10}$$

From, respectively, (C.8), (C.10) and $y = (\ell)^{1-\nu}(x^f)^{\nu}$, we get

$$\frac{dx^f}{d\tau^x} = -\frac{1}{1-\nu}\frac{x^f}{1+\tau^x} < 0 \tag{C.11}$$

$$\frac{d\ell}{d\tau^x} = -\frac{1}{1-\nu}\left[\frac{\sigma-1}{1-\nu} + \frac{1}{1-\nu+\tau^x}\right]\nu\frac{\ell}{1+\tau^x} \tag{C.12}$$

$$\frac{dy}{d\tau^x} = -\left[\frac{\sigma}{1-\nu} + \frac{1}{1-\nu+\tau^x}\right]\nu\frac{y}{1+\tau^x} < 0 \tag{C.13}$$

Noting that

$$GDP = (\ell)^{1-\nu}(x^f)^{\nu} - px^f = \left[\frac{1+\tau^x}{\nu} - 1\right] px^f$$

where the last equality uses (C.8), we obtain that

$$\frac{dGDP}{d\tau^x} = -\frac{\tau^x}{(1-\nu)\,(1+\tau^x)} px^f < 0 \tag{C.14}$$

The Ramsey optimal monetary problem can be written as

$$
\begin{aligned}
\max_{c^h, x^f, \ell} &= \frac{(\omega\Theta)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}}}{1-\sigma^{-1}} \left(c^h\right)^{1-\frac{1}{\sigma}} - \omega \frac{\ell^{1+\psi}}{1+\psi}\Bigg] \\
&\text{subject to} \\
\Theta c^h &= \ell^{1-\nu} \left(x^f\right)^{\nu} - p x^f \\
x^f &= \frac{\nu}{1-\nu} \frac{1}{p(1+\tau^x)} (\omega\Theta)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi+1}
\end{aligned}
\tag{C.15}
$$

The Lagrangian is

$$
\begin{aligned}
\mathcal{L} = & \frac{(\omega\Theta)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}}}{1-\sigma^{-1}} \left(c^h\right)^{1-\frac{1}{\sigma}} - \omega \frac{\ell^{1+\psi}}{1+\psi}\Bigg] + \lambda \left[\ell^{1-\nu} \left(x^f\right)^{\nu} - p x^f - \Theta c^h\right] \\
& + \mu \left[x^f - \frac{\nu}{1-\nu} \frac{1}{p(1+\tau^x)} (\omega\Theta)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi+1}\right]
\end{aligned}
\tag{C.16}
$$

The optimality condition for x^f is given by

$$
\mu = \left[p - \nu \left(\frac{\ell}{x^f}\right)^{1-\nu}\right] \lambda
$$

which combined with (C.16) yields

$$
1 - \frac{1}{\nu^{\nu} (1-\nu)^{1-\nu}} \left(p(1+\tau^x)\right)^{\nu} \left((\omega\Theta)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi}\right)^{1-\nu} = -\frac{p\tau^x + \frac{\mu}{\lambda}}{\nu \left(\frac{\ell}{x^f}\right)^{1-\nu}}
\tag{C.17}
$$

Note that the labor wedge is given by

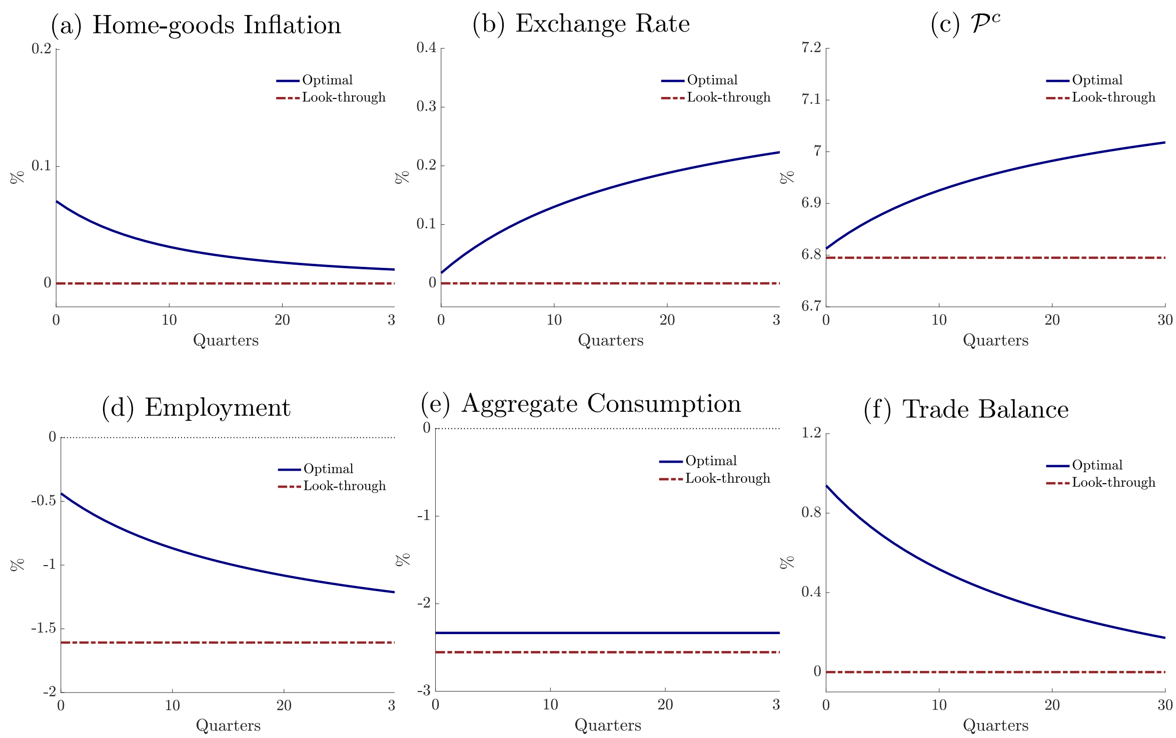
$$
\begin{aligned}
\wp &= 1 - \left(\frac{\omega \ell_t^{\psi}}{(1-\nu) u_h(c_t^h, c_t^f)}\right)^{1-\nu} \left(\frac{p(1+\tau_t^x)}{\nu}\right)^{\nu} \\
&= 1 - \frac{1}{\nu^{\nu} (1-\nu)^{1-\nu}} \left(p(1+\tau^x)\right)^{\nu} \left((\omega\Theta)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi}\right)^{1-\nu} \\
&= -\frac{p\tau^x + \frac{\mu}{\lambda}}{\nu \left(\frac{\ell}{x^f}\right)^{1-\nu}}
\end{aligned}
$$

where the second equality uses $\Theta \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma} p^{1-\gamma}$ and the last equality uses (C.17).

The result implies that the monetary authority overheats the economy in response to tariffs, mirroring the baseline results.

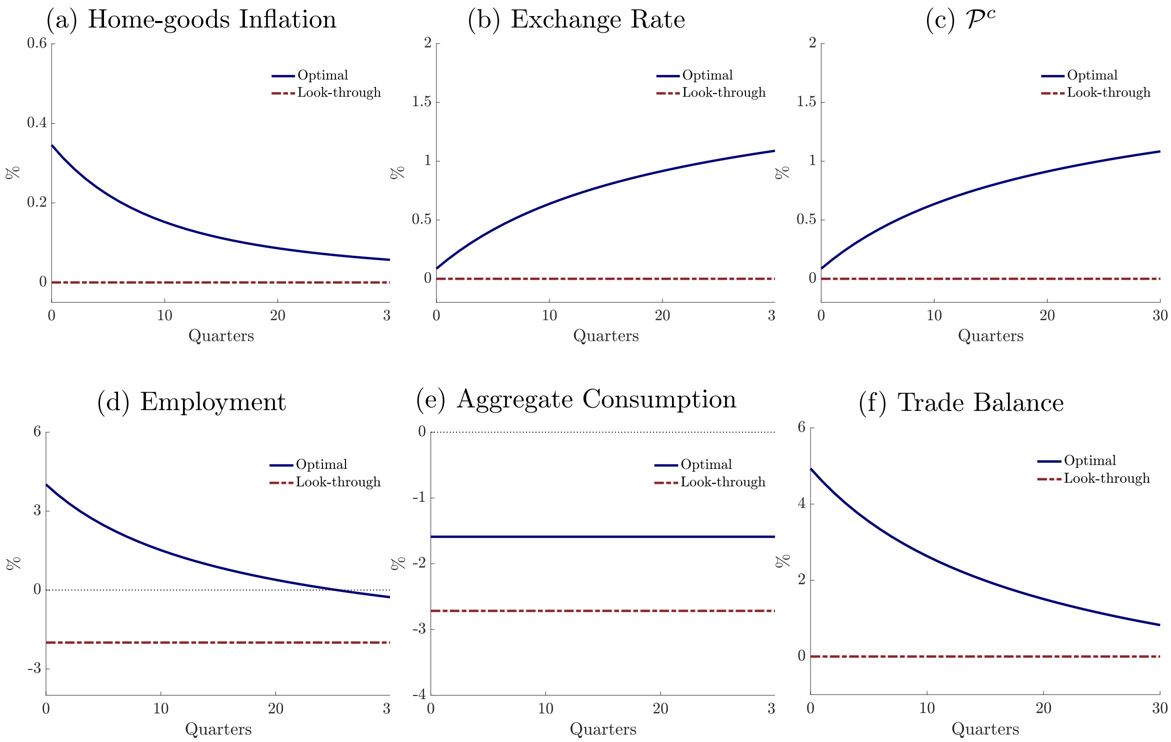
C.3 Simulations

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



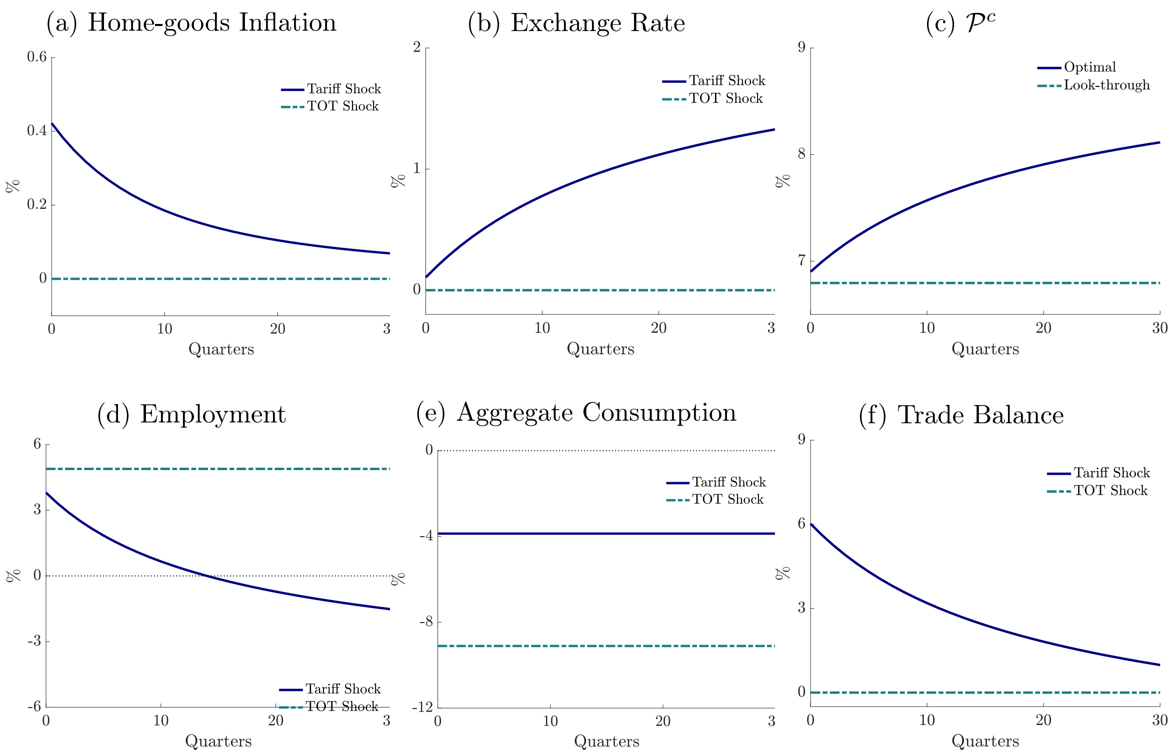
Notes: The tariffs are set to $\tau_t^c = 15\%$ and $\tau_t^x = 0$. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation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

Figure C.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 and the NFA position are 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 C.3: Terms-of-trade shocks versus tariffs in the model with imported inputs



Notes: We assume a permanent $\tau = 15\%$ for the tariff and a permanent increase in p of 15% in the case of TOT shocks. Inflation is annualized. The trade balance and the NFA position are 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.

D Extension with Distorted Steady State

D.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 (36) is given by

$$\ell = c^h + pc^f \tag{C.18}$$

$$c^f = \left(\frac{1-\omega}{\omega p (1+\tau)}\right)^{\gamma} c^h \tag{C.19}$$

$$\frac{W}{P^h} = \frac{\omega \ell^{\psi}}{u_h (c^h, c^f)} \tag{C.20}$$

$$P^h = \frac{\varepsilon}{\varepsilon - 1} (1-s) W \tag{C.21}$$

$$p\tau c^f = s \frac{W}{P^h} \ell \tag{C.22}$$

Using (C.20) and (C.22) to substitute for $\frac{W}{P^h}$ and s, we can rewrite (C.18), (C.19), (C.21) as

$$c^h = \frac{1+\tau}{\Theta_\tau + \tau} \ell \tag{C.23}$$

$$c^f = \frac{\Theta_\tau - 1}{p(1+\tau)} c^h \tag{C.24}$$

$$(\omega \Theta_\tau)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} (\ell)^{\psi} = \frac{\Theta_\tau - 1}{1+\tau} \frac{\tau c^h}{\ell} - \frac{\varepsilon - 1}{\varepsilon} \tag{C.25}$$

where recall that $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma} (p(1+\tau))^{1-\gamma}$. From (C.25), we obtain that

$$\ell(\tau) = \left[(\omega \Theta_\tau)^{\frac{\sigma-\gamma}{\gamma-1}} \frac{\Theta_\tau + \tau}{1+\tau} \left(\frac{\Theta_\tau - 1}{\Theta_\tau + \tau} \tau + \mathcal{M}^{-1} \right)^{\sigma} \right]^{\frac{1}{1+\sigma\psi}} \tag{C.26}$$

and

$$\left. \frac{d\ell(\tau)}{d\tau} \right|_{\tau=0} = \frac{1}{1+\sigma\psi} \frac{\sigma}{\varepsilon - 1} \frac{\Theta_\tau - 1}{\Theta_\tau} \ell(\tau) > 0 \tag{C.27}$$

Using (C.23) and (C.24), we can express welfare as

$$W(\tau) = \frac{1}{1-\beta}\left[\frac{1}{1-\frac{1}{\sigma}}\left((\omega\Theta_\tau)^{\frac{\gamma}{\gamma-1}}\frac{1+\tau}{\Theta_\tau+\tau}\right)^{1-\frac{1}{\sigma}}\ell(\tau)^{1-\frac{1}{\sigma}} - \frac{\omega}{1+\psi}\ell(\tau)^{1+\psi}\right] \tag{C.28}$$

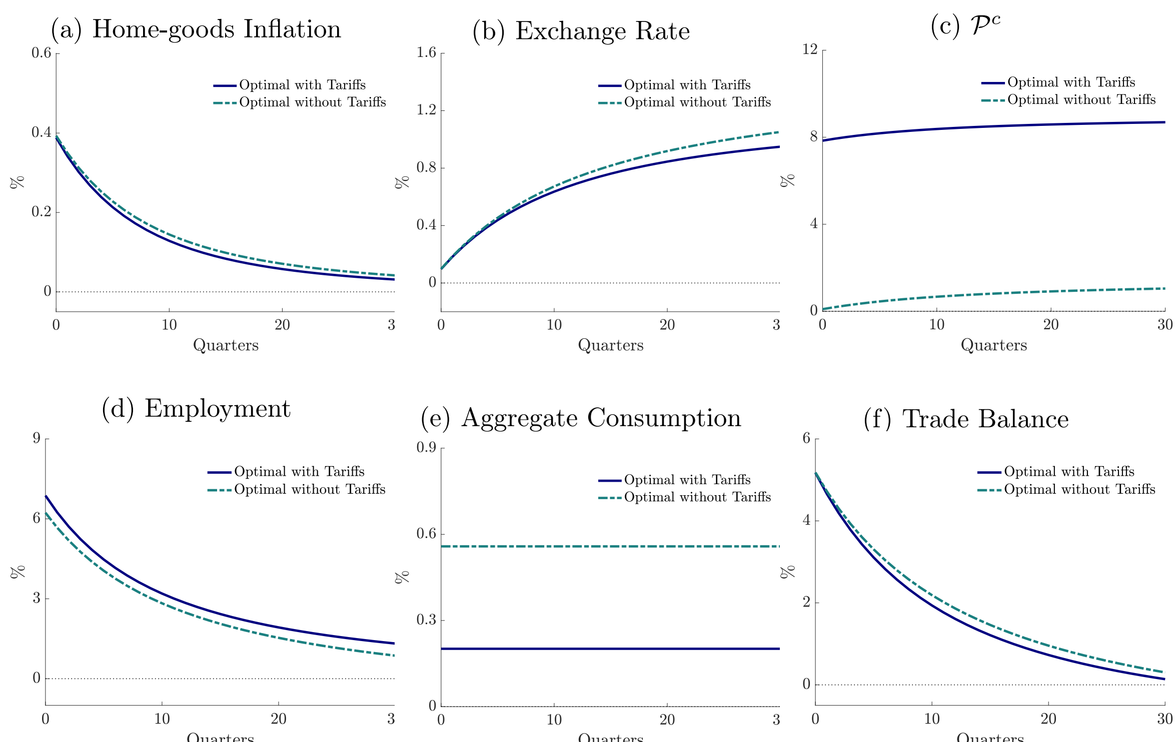
Differentiating (C.28) with respect to τ we get

$$W'(\tau)\Big|_{\tau=0} = \frac{1}{1-\beta}\frac{\omega}{(\varepsilon-1)^2}\frac{\sigma}{1+\sigma\psi}\frac{\Theta_0-1}{\Theta_0}\ell^{1+\psi} > 0. \quad \square \tag{C.29}$$

$\square$

D.2 Simulations with Distorted Steady State

Figure D.1: Distorted steady state



Notes: Impulse response to a permanent tariff of 15%. The subsidy on labor is given by $P_t^f \tau_t c_t^f = s_t W_t \ell_t$, as in (36). Consumption of home goods, employment, the exchange rate and the price level are expressed as percent deviation from the pre-tariff steady-state allocation with zero inflation.

E Extension with Endogenous Terms of Trade

E.1 Derivation of (37)

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 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

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

where c_{it} is a CES aggregate of the consumption of a home good c_{it}^h and the foreign good c_{it}^f is a composite of foreign 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

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

where $b_{i,t+1}$ denote the holding of international bonds, e_{it}^k is 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

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

Noting that all foreign countries are symmetric and applying (E.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

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

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 (E.2) as

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

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

$$p_t = \left[(1-\omega)c_t^*\right]^{-\frac{1}{\theta}}\left(y_t - c_t^h\right)^{\frac{1}{\theta}} \tag{E.3}$$

which corresponds to (37), and where $A \equiv \left[(1-\omega)c_t^*\right]^{-\frac{1}{\theta}}$ is an exogenous demand shifter.

E.2 Optimal Tariff

The optimal tariff solves

$$\max_{\{c_t^h, c_t^f, \ell_t, \tau_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c_t^h, c_t^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi}\right], \tag{E.4}$$

subject to

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

$$c_t^f = \left[\frac{1-\omega}{\omega A\left(\ell_t - c_t^h\right)^{\frac{1}{\theta}}(1+\tau_t)}\right]^{\gamma} c_t^h, \tag{E.6}$$

$$\omega \ell_t^{\psi} = u_h(c_t^h, c_t^f), \tag{E.7}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega\, \ell_t^{\psi}}{u_h(c_t^h, c_t^f)} - 1\right] + \frac{1}{R^*}\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \tag{E.8}$$

where we replace $p_t = A\left(\ell_t - c_t^h\right)^{\frac{1}{\theta}}$ from (37) in the intertemporal budget constraint.

Notice that because τ_t only appears in (E.6), we can infer that this constraint does not bind. Similarly, we can guess and verify that the last two constraint do not bind. In addition, if the last constraint does not bind, then $\pi_t = 0$ is optimal, as it relaxes (E.5) and (E.8) holds.

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

$$u_f(c_t^h, c_t^f) = \lambda p_t \tag{E.9}$$

$$u_h(c_t^h, c_t^f) = \lambda\left(1 - \frac{1}{\theta}\frac{p_t c_t^f}{\ell_t - c_t^h}\right) \tag{E.10}$$

$$\omega \ell_t^{\psi} = \lambda\left[1 - \frac{1}{\theta}\frac{p_t c_t^f}{\ell_t - c_t^h}\right] \tag{E.11}$$

where we denote by λ the Lagrange multiplier on (E.5). Note that combining the last two constraints verify that (E.7) holds at an optimum allocation. From (E.9) and (E.10), we get

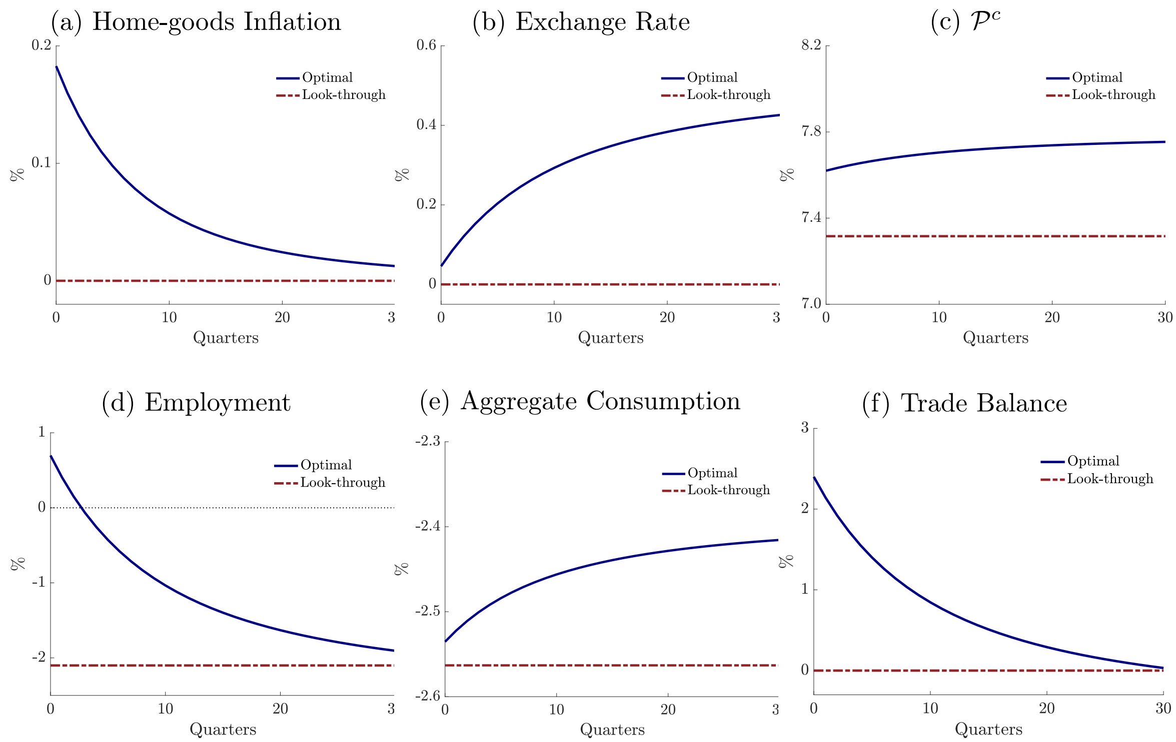
$$p_t \frac{u_h(c_t^h, c_t^f)}{u_f(c_t^h, c_t^f)} = 1 - \frac{1}{\theta}\frac{p_t c_t^f}{\ell_t - c_t^h}$$

Finally, using (E.6) and zero trade balance $p_t c_t^f = \ell_t - c_t^h$, we arrive at

$$\tau_t = \frac{1}{\theta - 1} \tag{E.12}$$

E.3 Simulations with Endogenous Terms of Trade

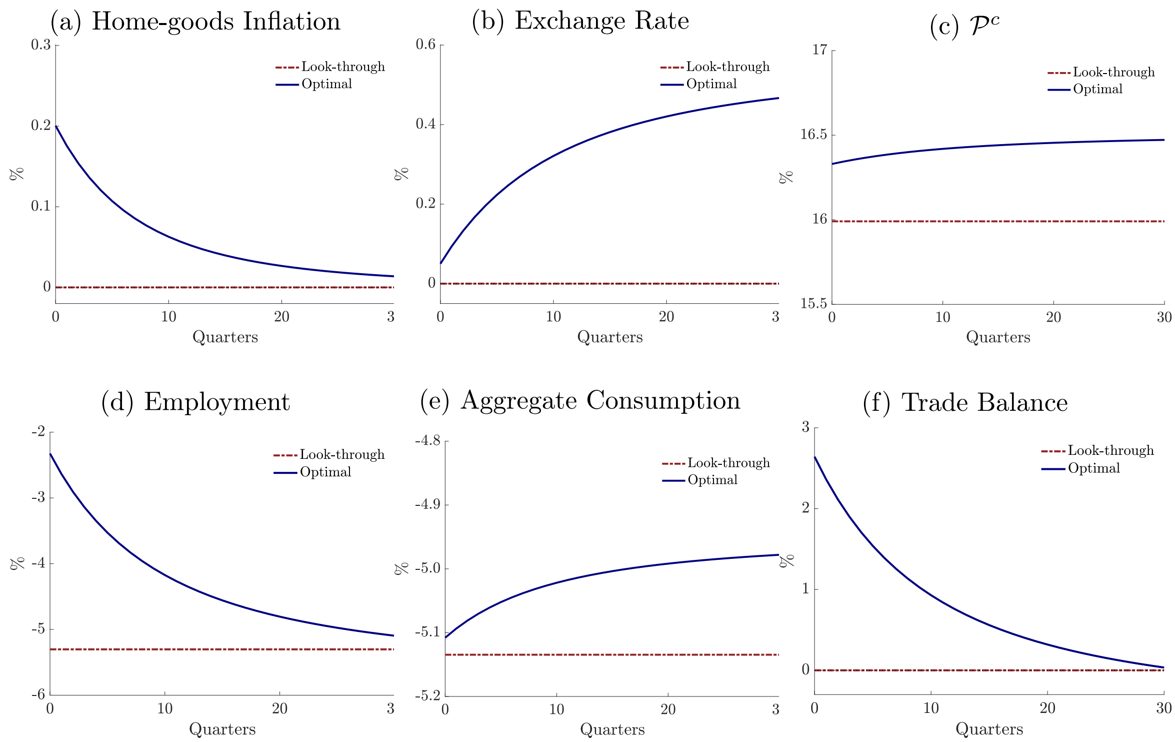
Figure E.1: Permanent shock to tariffs



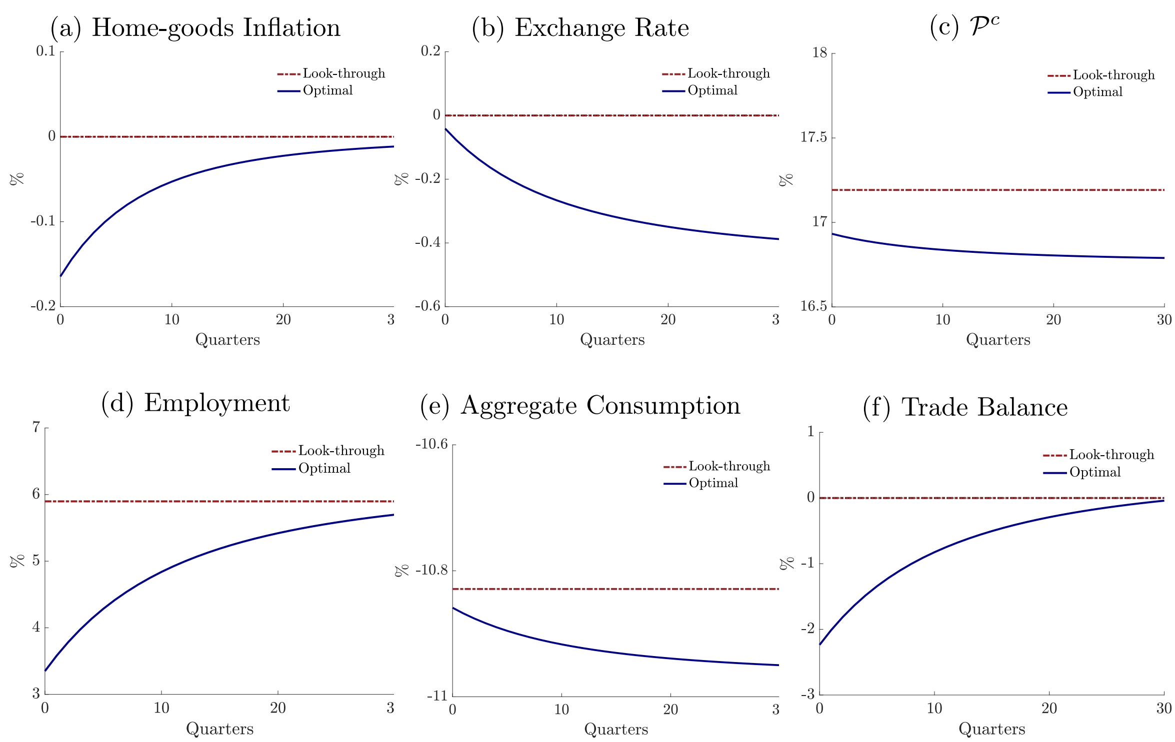
Notes: The figure displays the response to a permanent increase in tariffs of $\Delta\tau = 15\%$ starting from the optimal tariff. The relative price of imports is given by (37) and $\theta = 10$. The trade balance is expressed as a fraction of GDP. Consumption, employment, the exchange rate and the tradable price level are expressed as percent deviation from the allocations before the shock.

Figure E.2: Impulse response to a 26% permanent increase in tariff

Tariff Revenue Rebated

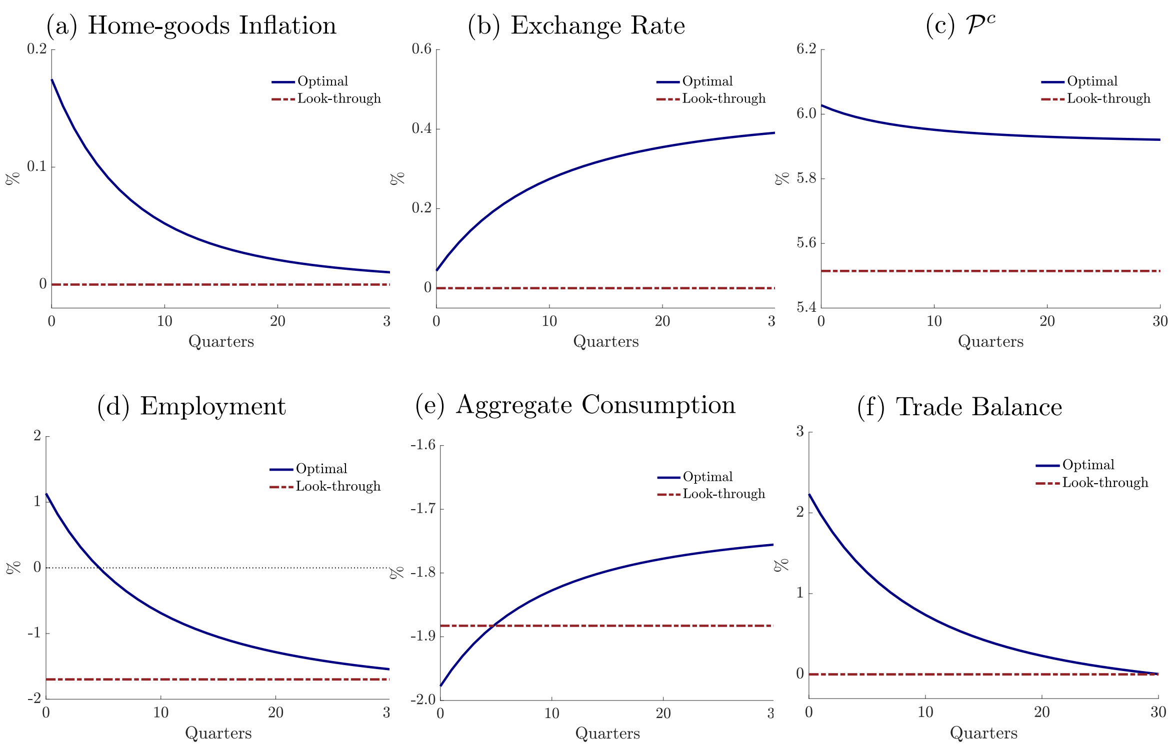


Tariff Revenue Wasted



Notes: The figure presents the impulse response to a 26% tariff starting from zero tariffs. The relative price of imports is given by (37) 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 percent deviation from the allocations that would prevail with zero tariffs.

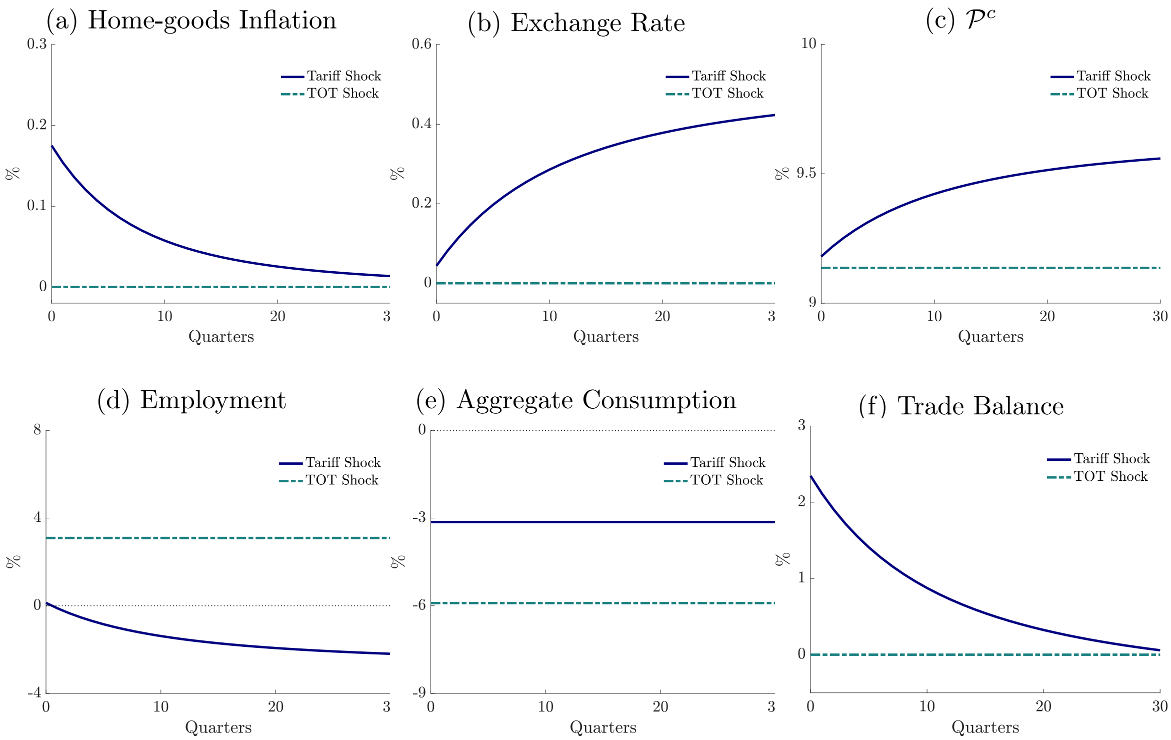
Figure E.3: Sensitivity to export elasticity ($\theta = 5$)



Notes: The figure displays the response to a permanent increase in tariffs of $\tau = 15\%$ starting from the optimal tariff. The relative price of imports is given by (37) 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 percent deviation from the allocations before the shock.

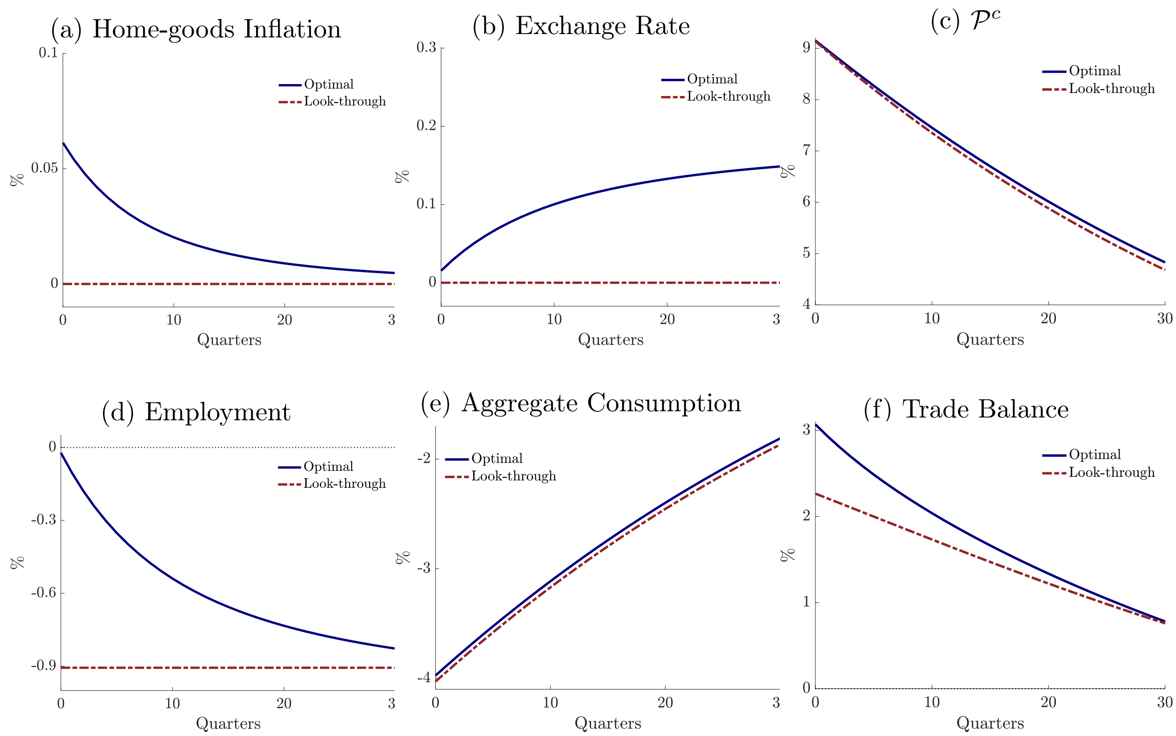
F Additional Figures for Baseline Model

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



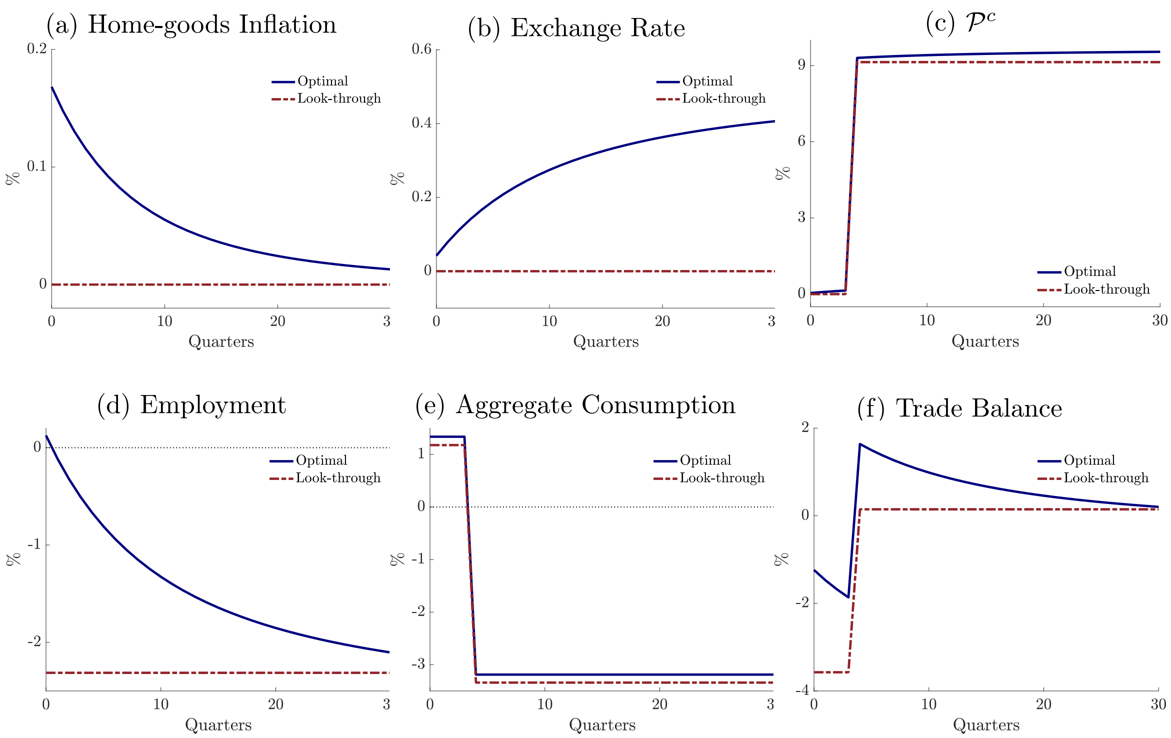
Notes: For the tariff shock, we set a constant tariff $\tau = 15\%$ and for the TOT shock, we assume a permanent 15% increase in p, driven by P^{f*}. In both cases, the simulations correspond to optimal monetary policy. Inflation is annualized. The trade balance and the NFA position are expressed as 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: 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 and the NFA position are 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.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 and the NFA position are 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.

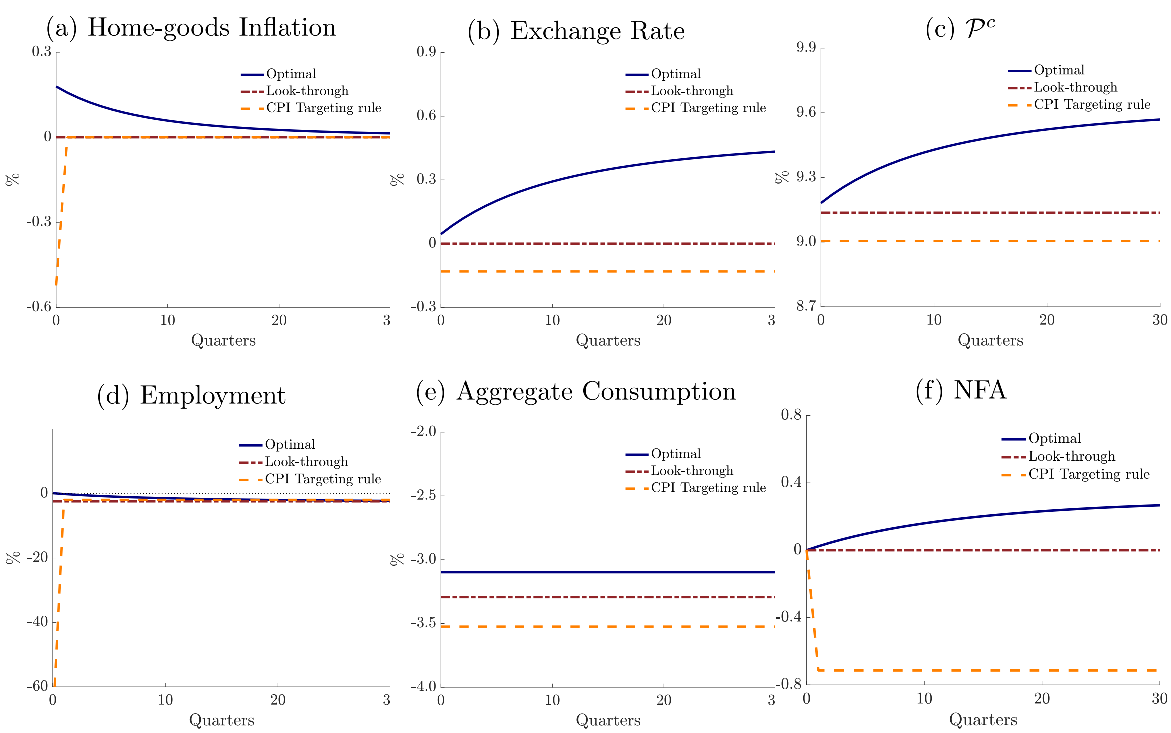
G Simulations under CPI Targeting

Table G.1: Welfare Implications

	Gains 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	0.006	0.04	0.10	0.69	0.72	0.78
Model w/ 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

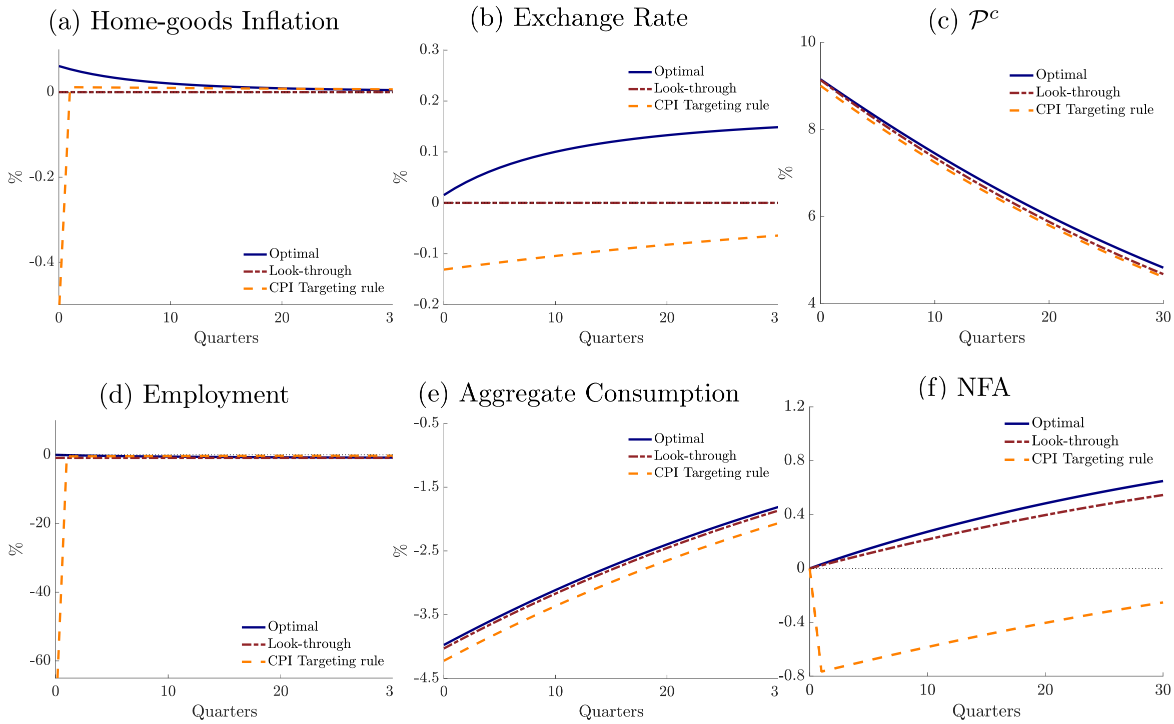
Note: Welfare corresponds to permanent consumption equivalence and is expressed in percentage.

Figure G.1: Baseline model with permanent tariff



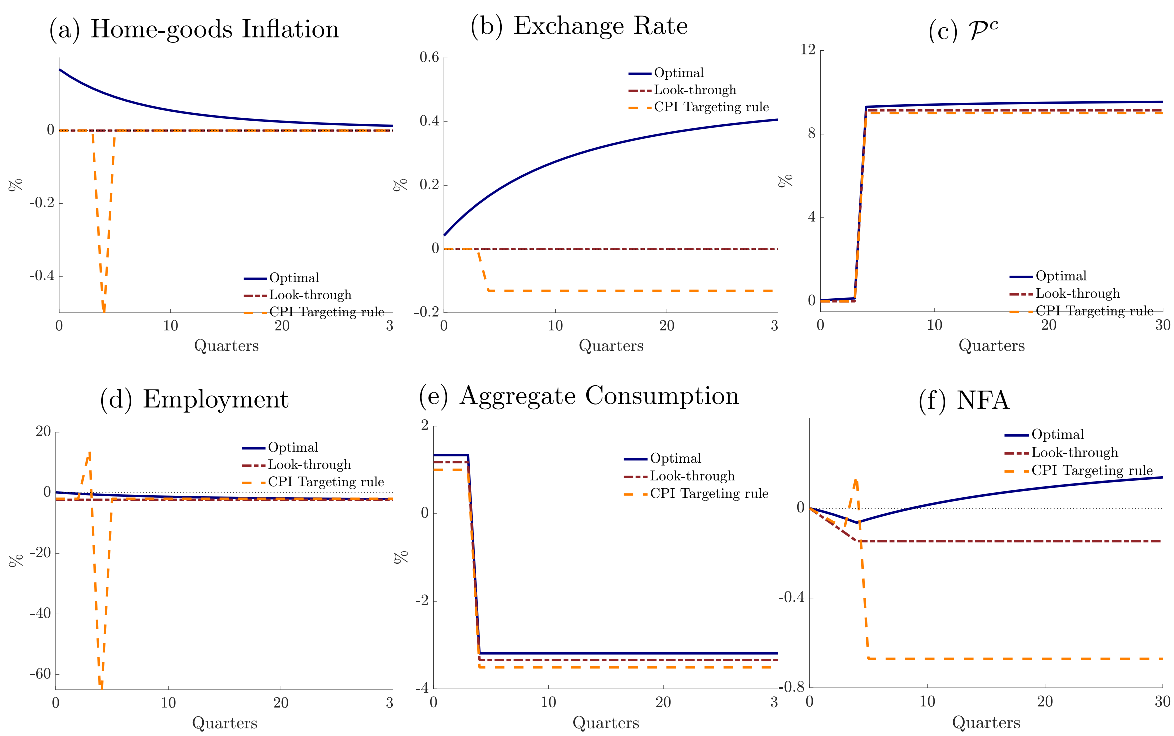
Notes: The tariff is set to $\tau_t = 15\%$ for all t. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable consumer price level, $\mathcal{P}^c$, are expressed in percentage deviation from the pre-tariff allocation.

Figure G.2: Baseline model with temporary tariff



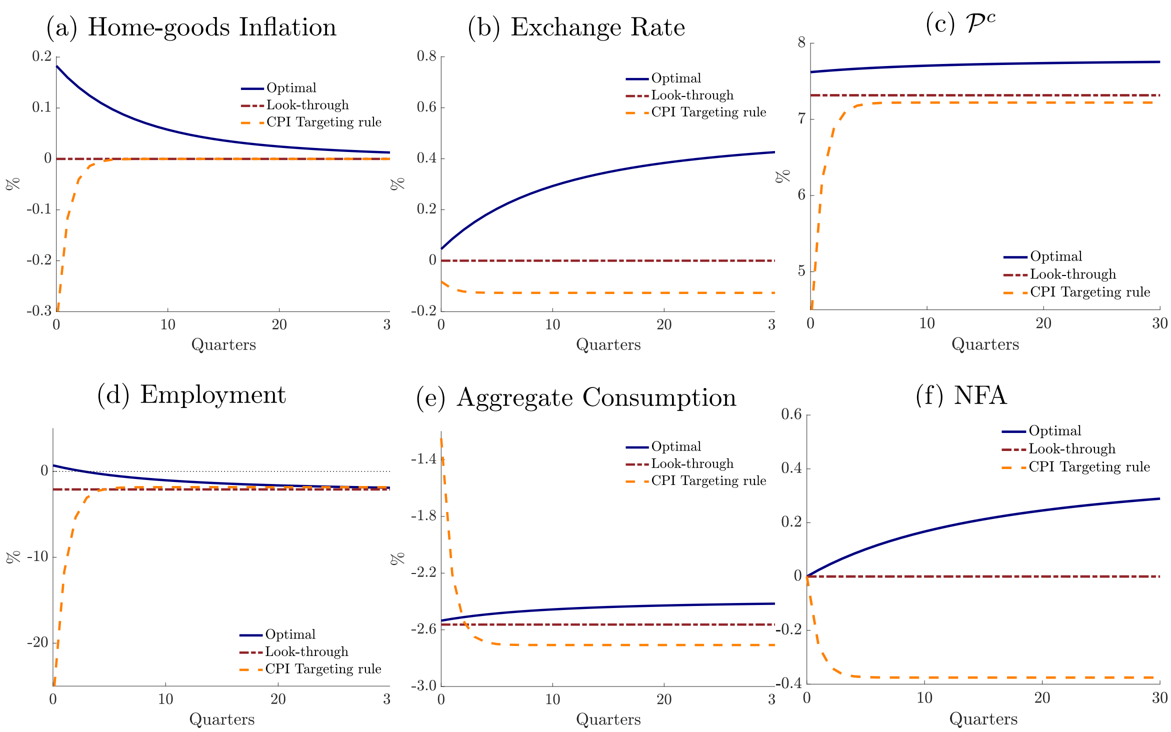
Notes: The tariff follows $\tau_t = \rho\tau_{t-1}$ with $\tau_t = 15\%$ and $\rho = 0.976$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure G.1 for further details.

Figure G.3: Baseline model with anticipated tariff



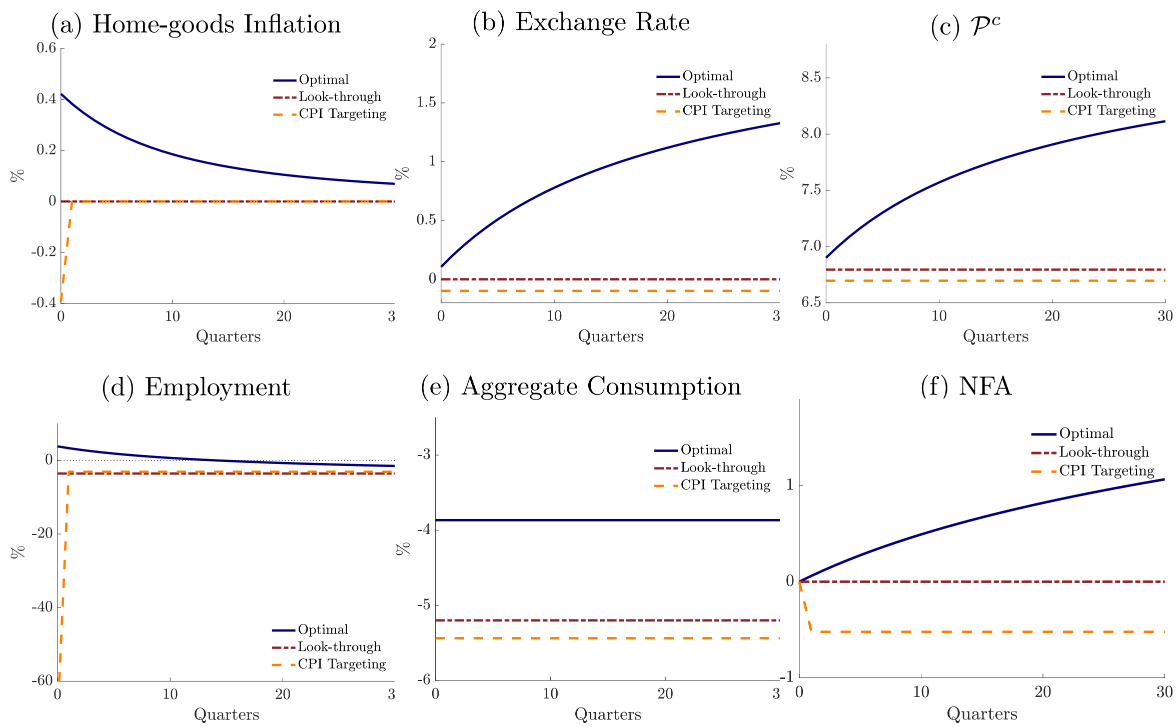
Notes: A permanent tariff of 15% is announced at $t = 0$ and imposed at $t = 4$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See note on Figure G.1 for further details

Figure G.4: Simulations with Endogenous Terms of Trade



Notes: The figure displays the response to a permanent tariff of $\tau = 15\%$ when the relative price of imports is given by (37) and $\theta = 10$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure G.1 for further details.

Figure G.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 (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure G.1 for further details.