NBER WORKING PAPER SERIES

THE OPTIMAL MONETARY POLICY RESPONSE TO TARIFFS

Javier Bianchi
Louphou Coulibaly

Working Paper 33560
http://www.nber.org/papers/w33560

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2025, Revised April 2025

We thank Michael Devereux and Simon Lloyd for excellent discussions, Sushant Acharya, Charles Engel, Sebastian Fanelli, Alisdair McKay, Jonathan Heathcote, Rishabh Kirpalani, Andrea Raffo, Matt Rognlie, Ivan Werning, and Kei-Mu Yi for helpful conversations, and seminar participants at the Atlanta Workshop in International Economics, Board of Governors, the Central Bank of Chile, Johns Hopkins, and the University of Wisconsin-Madison. The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis, the Federal Reserve System, or the National Bureau of Economic Research. First Draft, December 6, 2024.

The Optimal Monetary Policy Response to Tariffs
Javier Bianchi and Louphou Coulibaly
NBER Working Paper No. 33560
March 2025, Revised April 2025
JEL No. E24, E44, E52, F13, F41

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.

Javier Bianchi
Federal Reserve Bank of Minneapolis
Department of Economics
javieribianchi@gmail.com

Louphou Coulibaly
University of Wisconsin - Madison
Department of Economics
and Federal Reserve of Minneapolis
and also NBER
lcoulibaly@wisc.edu

1 Introduction

The rise in tariffs in the US has sparked a debate about their inflationary consequences and the appropriate response of the Federal Reserve. One view holds that the Federal Reserve should tighten monetary policy to keep inflation in check. Another view argues that the Federal Reserve should "look through" the price increase driven by tariffs, as they reflect a one-off jump in the price level and thus require 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 may be *expansionary*. The logic is as follows: When a tariff is imposed, households and firms perceive the cost of importable goods to be higher than their social cost. This wedge arises because individual agents fail to internalize that higher imports generate additional tariff revenue, which, in equilibrium, raises household income. As a result, imports decline more than is socially optimal. To counteract the substitution effect of tariffs and mitigate the contraction in imports, the optimal monetary policy stimulates employment and aggregate income.

Our framework is a dynamic, open economy New Keynesian model that features home-produced and importable goods. Our baseline model assumes that imported goods are final consumption goods and that international relative prices are exogenously given; however, we also extend our results to cases where imports serve as intermediate inputs and where international prices vary with domestic output. In the absence of tariffs, the optimal policy follows the canonical prescription of New Keynesian models, where the monetary authority is able to achieve 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. We show that the Ramsey-optimal policy overheats the economy, raising both employment and inflation above their efficient levels. 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 boosts the demand for imports, generating strictly positive first-order gains. This makes it optimal for the monetary authority to tolerate some overheating.

Our analysis challenges the conventional wisdom on the effects of tariffs on exchange rates and capital flows. The dominant view, rooted in the Mundell-Fleming framework, holds that tariffs lead to an appreciation of the exchange rate and have no effect on the trade

[1] For these two views, see remarks by Governor Adriana Kugler who stated that "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."

surplus when the tariff is permanent. 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. This occurs because an expansionary monetary policy depreciates the exchange rate and the higher short-run level of employment leads households to accumulate foreign assets. Consistent with our results—and against the conventional view—the dollar depreciated against a basket of currencies following the tariff announcement on April 2.

We begin our theoretical analysis by characterizing the macroeconomic effects of tariffs. In a flexible-price benchmark, or equivalently under a policy that maintains zero Producer Price Index (PPI) inflation, we first show that the employment response is ambiguous. Unlike a standard consumption tax, tariffs generate two distinct substitution effects: (i) between labor and foreign consumption and (ii) between domestic and foreign consumption. The direction of the employment response depends on the relative magnitudes of the intertemporal elasticity of substitution and the intratemporal elasticity, as well as the size of the tariff. Specifically, when the intratemporal elasticity exceeds the intertemporal elasticity—implying that home and foreign goods are Hicksian substitutes—employment increases for sufficiently high tariffs. However, we show that, starting from zero tariffs, a marginal increase in tariffs necessarily reduces employment, and for empirically plausible values of elasticities and tariffs, employment contracts.

We then turn to the analysis of optimal policy. We first derive a number of analytical results in a version of the model in which firms face price adjustment costs, but these do not entail any resource costs for the economy. We show that under the optimal policy, employment increases in response to a tariff when the intertemporal elasticity of substitution is below one, and decreases when it is above one. However, regardless of whether employment contracts or expands, the level is always higher than the policy that maintains zero PPI inflation. Crucially, *tariffs induce the monetary authority to let the economy overheat, generating simultaneously a positive output gap and inflation*. We emphasize that the optimal monetary policy response to tariffs differs fundamentally from that to a cost-push shock, where the monetary authority induces a *negative* output gap to contain inflation.

The optimal policy response to tariffs also contrasts with that 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 (e.g., Aoki, 2001 and Hevia and Nicolini, 2013). Since divine coincidence holds, this implies that the output gap remains at zero and the CPI experiences a one-time increase. The reason a look-through policy is optimal in this case is that the increase in import prices reflects a genuine rise in the social cost of foreign goods. By contrast, tariff-induced increases in import prices reflect only a rise in private costs, not social costs. To mitigate this distortion, the monetary authority must stimulate the economy—allowing PPI to rise, boosting aggregate income, and sustaining higher consumption of imported goods.

Our quantitative simulations indicate that the monetary authority finds it optimal to deviate significantly from the allocation with zero PPI inflation and a zero output gap. We consider a uniform 10% tariff, following the Trump administration policy. Under a look-through policy, we find that employment falls about 4%, although the output gap remains at zero as the monetary authority targets PPI inflation. We find that under the optimal policy employment stays roughly constant on impact and the labor wedge becomes negative. In addition, PPI inflation reaches 0.4% (annualized), raising overall inflation above and beyond the effect of tariffs on foreign goods.

We explore several extensions of the baseline framework, including alternative durations and timing of the tariff increase, the inclusion of imported intermediate inputs, and endogenous terms of trade. Across all these cases, we find that the optimal monetary policy remains expansionary, with inflation rising beyond the direct effects of the tariff. Furthermore, we show that the presence of tariffs on intermediate inputs lead to a larger fall in employment under look-through, while employment increases on impact under optimal policy. Additionally, we find that the anticipation of future tariffs can exacerbate the trade-offs faced by the monetary authority, as an expansionary policy raises inefficiently imports prior to the implementation of the tariff.

We also examine a scenario in which the economy begins from a distorted steady state with a positive markup. 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, there is a rise in employment, while the inflationary pressures are 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 the condition equating the marginal rate of substitution between the two goods to their relative price. Because of the steady-state markup, the classic principle from Diamond and Mirrlees (1971), uniform taxation on consumption goods does not apply.

Literature. This paper contributes to the literature on the macroeconomic implications of tariffs. The role of tariffs as a macroeconomic policy tool dates back at least to Keynes, who argued that protectionist measures could help stabilize employment. By contrast, Mundell (1961) showed that tariffs are contractionary under a flexible exchange rate regime. His argument—which continues to be central in modern policy discussions—is that tariffs lead to an appreciation of the exchange rate which offsets or even outweighs the expenditure-switching effect toward domestic goods (see also, e.g., Krugman, 1982). Several recent studies have also examined tariffs as a macroeconomic policy tool within New Keynesian open economy models (Auray, Devereux and Eyquem, 2022, 2024a,b; Barattieri, Cacciatore and Ghironi, 2021; Bergin and Corsetti, 2020; Comin and Johnson, 2021; Eichengreen, 2019; Erceg, Prestipino and Raffo, 2023; Jeanne and Son, 2024; Jeanne, 2021).[2] In particular, Auray et al. (2024b) show how different monetary policy regimes affect the optimal setting of tariffs.

Our paper differs from the above literature in that it aims to characterize the optimal monetary response to an exogenously given import tariff. 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. Our work also complements existing studies by analytically characterizing the conditions under which tariffs either contract or expand employment and by showing how this depends on the monetary policy regime.

Bergin and Corsetti (2023) examine Ramsey optimal *cooperative* monetary policy in response to tariffs in a two-country framework. In a simple environment with complete markets and unitary elasticities of substitution, they find that the optimal response is neutral for the tariff-imposing country. In a richer quantitative model, they find that it becomes *contractionary*, while the optimal policy is expansionary for the tariff-targeted country and under symmetric trade wars. In contrast, we study optimal monetary policy from the perspective of the tariff-imposing country and show that it is expansionary, even without foreign retaliation. Our analytical results also clarify 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 the literature on optimal monetary policy. In particular, we share with a subset of studies a focus on steady-state distortions, such as those arising from

[2]For additional work at the intersection of trade policy and international macroeconomics, see, e.g., Barbiero, Farhi, Gopinath and Itskhoki (2019), Lindé and Pescatori (2019), and Costinot and Werning (2019) for Lerner symmetry, Steinberg (2019), Caldara, Iacoviello, Molligo, Prestipino and Raffo (2020), and Alessandria, Khan, Khederlarian, Ruhl and Steinberg (2025) for trade policy uncertainty, Cuba-Borda, Queralto, Reyes-Heroles and Scaramucci (2025) and Ambrosino, Chan and Tenreyro (2024) for the inflationary consequences of a rise in trade costs, and Lloyd and Marin (2024) for the interaction with capital controls. See also Bagwell and Staiger (2016); Caliendo and Parro (2022) for surveys of the literature on trade policy.

markups or taxes (see, e.g., Woodford, 2011 and Galí, 2015 for textbook treatments).[3] A well-known result in the literature is that in the absence of a subsidy to offset firms' market power, optimal monetary policy tolerates inflation to reduce the labor wedge. Unlike a broad-based consumption or labor tax, a tariff taxes the foreign consumption good. This distinction is crucial because as we show, a tariff does not operate as a cost-push shock: the optimal policy *simultaneously* induces inflation and a positive output gap.

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. By contrast, our open economy model features production in a single sector, with a tax that distorts relative consumption across sectors. Unlike the case of a terms-of-trade shock highlighted in Aoki (2001), we show that optimal policy response to tariffs calls for positive PPI inflation and a positive output gap.[4]

Finally, a fast-growing literature is emerging following the 2025 Trump administration tariffs. In particular, Monacelli (2025) shows that while 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 general equilibrium response to tariff shocks in a multi-sector model with international production networks.

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. All proofs are in the appendix.

[3]See also Afrouzi, Halac, Rogoff and Yared (2023) for a recent example in a dynamic non-linear framework where the central bank lacks commitment.

[4]A burgeoning literature has incorporated rich sectoral considerations to understand post-Covid inflation 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, Kalemli-Özcan, Silva and Yildirim, 2022; Fornaro and Romei, 2023; Gagliardone and Gertler, 2023; Guerrieri, Lorenzoni, Straub and Werning, 2021, 2022; La'O and Tahbaz-Salehi, 2022; Rubbo, 2023; Woodford, 2022).

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

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

The term c_t is a composite between home and foreign consumption goods:

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

where $\omega \in (0,1)$ represents the preference weight for home goods, $\gamma \geq 0$ is the elasticity of substitution between home and foreign goods, and $\sigma \geq 0$ is the intertemporal elasticity of substitution.

Denote by P_t^h and by P_t^f the prices of the home and foreign good (pre-tariff), both expressed in domestic currency and $p = \frac{P_t^f}{P_t^h}$, the relative price. We assume that p is exogenous. This assumption can be interpreted as foreign households treating the home good as a perfect substitute for goods produced in other countries. We view this feature as appealing because it allows us to abstract from incentives for terms-of-trade manipulation.[5] 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, Goldberg, Kennedy and Khandelwal, 2020; Cavallo, Gopinath, Neiman and Tang, 2021).

We assume that the law of one price holds for both domestic and foreign goods (pre-tariffs). Without loss of generality, we normalize the foreign-currency price of the home good to one and assume that both goods have constant prices in foreign currency. Let e_t denote the

[5] Following Galí and Monacelli (2005), it is common to assume that each country is a monopolistic producer of a tradable good, thereby possessing market power over the terms of trade and creating scope for optimal tariffs. In Section 5.3, we extend our framework to incorporate endogenous terms of trade.

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 domestic currency and 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. We assume that prices are constant in foreign currency, and thus 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.[6] The first-order conditions yield the following:

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

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

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

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

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

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

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

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

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

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 primary focus, 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, $\ell_t = \int_0^1 \ell_{jt} dj$;

iii) 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:

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

subject to

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

Optimality implies that

$$u_h(c_t^h, c_t^f) = \omega \ell_t^{\psi}, \tag{10}$$

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

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

These three conditions indicate that the planner equates: (i) the marginal utility benefit from one extra unit of labor to the marginal utility cost from working, (ii) the marginal rate of substitution between home and foreign goods to the relative international price, (iii) and the marginal utility benefits from raising one unit of home good consumption to the marginal benefit from saving in bonds and consuming one additional unit next period.

Comparing the efficient allocation with the competitive equilibrium, we can see two distortions introduced by nominal rigidities and tariffs. First, from (6), we can see that nominal rigidities potentially imply that the wage deviates from the marginal product of labor, which implies a deviation from (10). 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 provide an analytical characterization of the optimal monetary policy response to tariffs. We consider the case with government commitment. The Ramsey optimal monetary policy consists of choosing the competitive equilibrium that maximizes welfare. We can write the problem as follows:

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

subject to

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

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

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

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

We define a look-through policy as a policy that targets PPI inflation.

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

It is important to highlight that a policy of targeting PPI inflation is equivalent to implementing the flexible price allocation. In connection 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 jump in response to tariffs (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). In this vein, our first result is that in the absence of tariffs, a monetary authority that follows a look-through policy achieves the efficient allocation—that is, the 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.*

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.

We will study below how the monetary authority finds it optimal to depart from targeting PPI inflation in the presence of tariffs.

3.1 Analytical Results with $\Upsilon = 0$

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 $\beta R^* = 1, \tau_t = \tau, b_0 = 0$.*

These assumptions imply that the path of consumption is constant and that the trade balance is zero. As defined above, the monetary authority keeps PPI inflation at zero, and thus lets CPI inflation rise in response to the introduction of tariffs.

For the optimal policy, note that in 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 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 write the monetary authority's problem as maximizing a static problem

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

$$\text{subject to}$$

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

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

In effect, this optimal monetary policy problem is *equivalent to the problem of a planner choosing labor on behalf of households and letting households choose 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 $\Upsilon = 0, \tau > 0$. Then, the level of employment under look-through policy and optimal policy are* *given respectively by*

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

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

where we define $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^\gamma (p(1+\tau))^{1-\gamma} > 1$.

In addition, the levels of consumption are given by

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

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

The intuition for why the optimal employment is higher than the look-through is as follows. The monetary authority internalizes that when households work more, they demand more imports and raise tariff revenue, therefore raising aggregate income for all households. Because tariffs depress inefficiently the level of imports, the monetary authority induces a negative labor wedge, or equivalently a positive output gap, which implies that employment exceeds the level in the look-through policy.[7]

The proposition also highlights that the optimal policy induces a positive level of inflation. Intuitively, given that employment under the optimal policy exceeds the level associated with the zero-inflation allocation, implementing this higher level of consumption requires higher inflation to stimulate the economy.

How tariffs affect employment. We turn next to analyze how tariffs affect employment in each of the two monetary policy regimes. To examine the effect, we differentiate the employment functions derived in Proposition 2. The Corollary below presents the response under the look-through policy and shows that tariffs can be contractionary or expansionary.

Corollary 1. *Under the look-through policy, the effect of tariffs on employment is given by*

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

Notice that tariffs do not necessarily have monotonic effects on employment. While the

[7] Note that given the utility function we consider, preferences are homothetic in our setup. We expect our results to hold generally for any preferences where both home and foreign goods are normal.

first term is negative, the second term has an ambiguous sign. Therefore, depending on parameter values, it is possible to obtain that a higher tariff either increases or decreases employment. One may have expected that to the extent that tariffs are a tax on consumption, they operate indirectly as a tax on labor supply, thereby always depressing employment. In particular, a tax on labor income induces a negative substitution effect on labor supply, while the fiscal transfer generates a wealth effect that unambiguously reduces employment. However, the equivalence between a labor tax and consumption taxes does not extend to the case where there are multiple consumption goods and the tax applies to only one of them.

The ambiguity arises because tariffs affect two key relative prices: the price between foreign and home goods and the price between foreign goods and labor. These shifts induce two distinct substitution effects. The first one is that a tariff reduces the real wage in terms of foreign consumption goods, leading to a substitution away from labor. The second one is that when $\gamma > \sigma$, we have that for a sufficiently large level of tariff, an increase in the tariff at the margin induces an increase in labor supply. The intuition for this perhaps surprising result is as follows. When the elasticity of substitution between home and foreign consumption exceeds the intertemporal elasticity of substitution, home and foreign goods are Hicksian substitutes, which implies that a lower foreign consumption leads to an increase in the marginal utility of home goods (i.e., $u_{h,f} < 0$). As a result, a tariff that depresses c^f may lead households to increase their labor supply given the higher marginal utility value associated to c^h.

Nonetheless, evaluating (21) at $\tau = 0$ indicates that an increase in tariffs always reduces employment under the look-through policy. That is, a small tariff necessarily reduces employment under the look-through policy. We also note that for the parameterizations and tariff magnitudes considered, tariffs will quantitatively reduce employment under the look-through policy.[8]

The effect of tariffs on employment under optimal policy differs substantially from its effect on employment under look-through policy. As we show below, the sign of the employment response is determined entirely by the intertemporal elasticity of substitution.

Corollary 2. *Under optimal monetary policy, the effect of tariffs on employment is given by*

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

[8] 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 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. Notice, however, that here the contraction in employment under look-through occurs without movements in the exchange rate. Our analytical results help to transparently illustrate the channels and complement quantitative simulations in dynamic microfounded models (see e.g., Barattieri et al., 2021).

For $\sigma < 1$, employment increases and for $\sigma > 1$, employment decreases. As discussed above, a lower σ makes home and foreign goods more substitutes (in the Hicksian sense), and thus monetary policy becomes more effective at preventing a larger drop in imports by stimulating employment.

A case that is especially simple is $\gamma = \sigma = 1$ and $\psi \to 0^+$. Specializing Proposition 2 to this case and setting $\tau = 0$, we obtain that the efficient allocation yields

$$\ell^\star = \frac{1}{\omega}, \quad c^{h,\star} = 1, \quad c^{f,\star} = \frac{1-\omega}{\omega p},$$

while the look-through and optimal policy are given by

$$\begin{aligned} \ell^{look} &= \left(\frac{1+\omega\tau}{1+\tau}\right)\frac{1}{\omega}, & c^{h,look} &= 1, & c^{f,look} &= \left(\frac{1}{1+\tau}\right)\frac{1-\omega}{\omega p}, \\ \ell^{opt} &= \frac{1}{\omega}, & c^{h,opt} &= \frac{1+\tau}{1+\omega\tau}, & c^{f,opt} &= \left(\frac{1}{1+\omega\tau}\right)\frac{1-\omega}{\omega p}. \end{aligned}$$

In this simple example, we find that home consumption remains at its efficient level under the look-through policy, while employment attains the efficient level under the optimal policy, regardless of the tariff rate. Moreover, as before, optimal policy stimulates employment, and tariffs reduce foreign consumption under both regimes.

One lesson from the analysis is that 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. Another important lesson is that 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. Underlying this result is a fiscal externality, which we turn to discuss below.

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, we have substituted in all the implementability constraints so that the monetary authority's problem can be reduced to choosing c^f.

The optimal level of imports c^f, given τ, satisfies

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

where we substituted (16). 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 leads 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.

Tariffs vs. TOT shock: The role of fiscal revenue. To highlight the role of tariff revenue, consider a scenario in which tariffs are introduced but the revenue "is thrown into the ocean". In this case, the monetary authority's problem in (13) faces the following intertemporal budget constraint

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

instead of (14). Notice that this budget constraint is identical to the one that would emerge when there is a terms of trade (TOT) shock that changes the price by $1 + \tau$. It follows from (24) that *a tariff where the revenue is not rebated is equivalent to a TOT shock.* The proposition below characterizes the optimal policy in this case.

Proposition 3 (Optimal policy absent fiscal rebate)**.** *Suppose that Assumption 1 holds, $\tau > 0$, and $T_t = 0$. 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 tariff has the same effects as a change in p.

This proposition shows that the optimal monetary response to a tariff that is not rebated (or to a TOT shock) is $\pi_t = 0$. From the perspective of an individual household, an increase in the price of foreign goods has the same implications, regardless of whether it is driven by a change in p or τ. However, on the aggregate the implications are different. When tariff revenue is rebated, households fail to internalize that higher imports raise the fiscal transfer received by all households. As discussed above, it is this fiscal externality that leads the monetary authority to deviate from targeting PPI inflation.

Comparing (25) with the values in Proposition 2 further reveals that when tariff revenue is not rebated, employment is higher than under a look-through policy in our baseline model where tariffs are rebated. Specifically,

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

This result is intuitive, as the rebate generates a wealth effect that reduces labor supply. However, under optimal policy, employment may be either lower or higher than in the case without a rebate, depending on the relative strength of the stimulative effect of monetary expansion and the contractionary wealth effect.[9]

3.2 General Setting with $\Upsilon > 0$

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.[10]

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

[9]By contrast, both imports and consumption of home goods are strictly lower under a terms-of-trade shock than under the optimal policy with rebated tariffs.

[10]Note that the level of Υ does not play a role under look-through policy or under the optimal policy when tariff revenue is not rebated, since in both cases $\pi_t = 0$ and there are no costs from changing inflation.

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

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

$$c^f \leq \left[\frac{1-\omega}{\omega p(1+\tau)} \right]^{\gamma} c^h, \qquad [\xi] \tag{28}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi} \left[\frac{\omega \ell_t^{\psi}}{u_h(c^h, c^f)} - 1 \right] + \beta \frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \qquad [\eta_t] \tag{29}$$

with Lagrange multipliers in brackets. We note that while the implementability constraints (28) and (27) hold with equality at the optimum, we express them with inequality to reflect 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 (29) (i.e., reducing inflation).

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 equating the MRS to the relative price, (28). That is, since the 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 (29).

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

(28). 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 Lagrange multiplier on the relative price-MRS constraint (28) (which is associated with a higher tariff), will be associated with a higher Lagrange multiplier on the PC 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 from 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 these conditions is that the monetary authority perceives a higher cost from inflation far 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 $1 + 2\pi_0 > 0$.[11] 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. Denote the labor wedge as

$$\wp_t \equiv 1 - \frac{\omega \ell_t^{\psi}}{u_h(c_t^h, c_t^f)}$$

The next proposition shows the optimal monetary policy overheats the economy in the sense

[11] 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 PC holds and we have the same ℓ and higher c^f and c^h. Thus, any allocation with $\pi_0 < -0.5$ is dominated.

that it induces a negative labor wedge.

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, to a first-order, the labor wedge is given by*

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

That is, the optimal monetary policy is expansionary.

The intuition for this result parallels the earlier case where inflation costs were absent. A tariff inefficiently depresses demand for imports. Starting from an allocation with zero inflation and a zero output gap, stimulating the economy does not create first-order costs, while the resulting increase in imports generates strictly positive first-order gains. This makes overheating a desirable outcome for the monetary authority. Notice that, unlike the case without inflation costs, the monetary authority implements a decreasing path for inflation. The intuition is that higher future inflation feeds into current inflation through the forward-looking Phillips curve, thereby increasing current resource costs.

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

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.[12] 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 to $\psi = 1$, in line with the estimates of Kimball and Shapiro (2008). As in Galí and Monacelli (2005), we set the elasticity of substitution between differentiated goods to $\varepsilon = 6$, which implies a price markup of 20%. We normalize the terms-of-trade p to 1 and calibrate the preference weight on home

[12] We solve for the sequence of allocations by using a Newton method that iterates on the set of non-linear difference equations that characterize the Ramsey problem.

goods to $\omega = 0.35$, which matches the ratio of imports to tradable GDP of 15.5%. The intertemporal elasticity of substitution is set to $\sigma = 2$.

Table 1: Calibration

Description	Value	Source/Target
Discount factor	$\beta = 0.99$	Real rate=4% (annual)
Elasticity between f and f	$\gamma = 2$	Baseline
Intertemporal elasticity	$\sigma = 2$	Baseline
Preference weight	$\omega = 0.35$	Imports to tradable-GDP = 15.5%
Frisch elasticity parameter	$\psi = 1$	Kimball and Shapiro (2008)
Elasticity of subs. varieties	$\varepsilon = 6$	Galí and Monacelli (2005)
Price-adjustment cost	$\varphi = 1636$	Slope of Phillips curve =0.005 (Hazell et al., 2022)

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, Herreno, Nakamura and Steinsson (2022). We set γ equal to 2, which lies within the empirical range (see Boehm, Levchenko and Pandalai-Nayar, 2023; Caliendo and Parro, 2022).

4.2 Baseline Results

We will assume throughout that the economy is initially at a steady state where $b_0 = 0$ and there are 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 express home-good inflation annualized, the trade balance and the NFA as a fraction of GDP, and consumption of home goods, employment, the price level, and the exchange rate are expressed as a percentage deviation from the pre-tariff allocation. We denote the (tradable) price level as $\mathcal{P}_t = \left[P_t^h \left(\omega^\gamma + (1-\omega)^\gamma (p(1+\tau_t))^{1-\gamma}\right)^{\frac{1}{1-\gamma}} \right]$. For reference, the black dotted line in the figures denotes the pre-tariff allocation.

Figure 1 presents the simulations in response to a permanent tariff of $\tau = 10\%$, in line

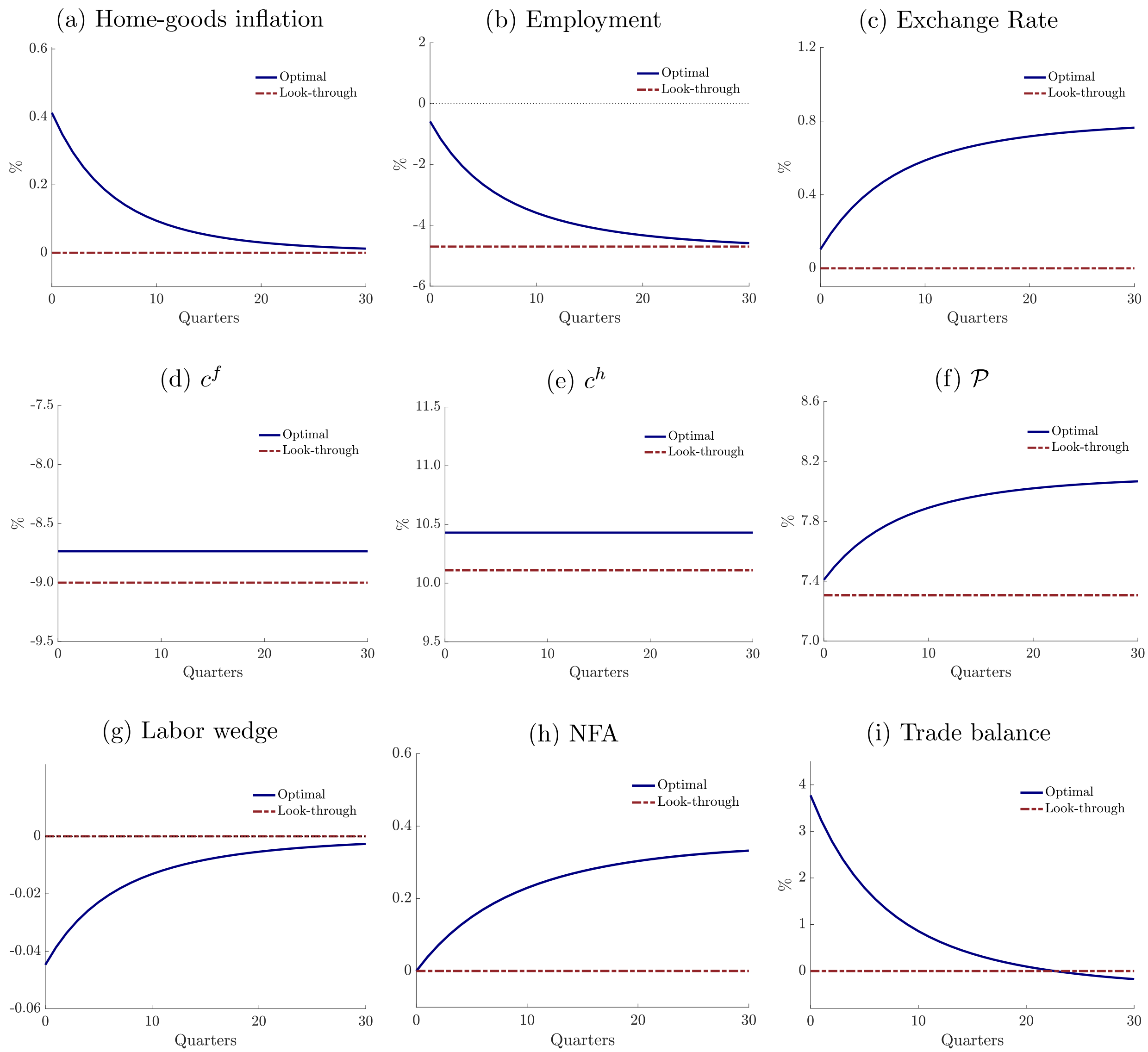


Figure 1: Baseline response to a permanent tariff

Notes: The tariff is set to $\tau_t = 10\%$ 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 price level are expressed in percentage deviation from the pre-tariff allocation.

with recent measures of the Trump administration.[13] We compare the optimal policy (blue solid line) with the "look-through" policy (red, dashed line). Recall that the look-through policy stabilizes inflation for home-produced goods (i.e., $\pi_t = 0$) while allowing the CPI to jump following the one-time increase in import prices. As the figure illustrates, under the look-through policy, the exchange rate, trade balance, and the NFA remain constant at their pre-tariff levels (panels c, h, and i). Moreover, consumption of home goods is permanently higher (panel d), and consumption of foreign goods is permanently lower (panel e), reflecting the increase in the price of the latter. Finally, employment declines (panel b) because, as discussed in Section 3.1, tariffs tend to depress labor supply.

Under the optimal policy, inflation and the exchange rate rise in the short-run (panels a and c) as the monetary authority seeks to stimulate employment and aggregate income. Notice that while employment falls slightly, the monetary authority mitigates the fall relative to the look-through policy and this results in a negative labor wedge (panel g). It is worth highlighting that the optimal monetary policy response differs from the traditional cost-push shocks where the monetary authority typically depresses employment and output to alleviate the inflationary pressure. Here, optimal policy calls for overheating the economy, inducing positive inflation and a positive output gap.

Over time, inflation falls and converges to zero in the long-run. The long-run allocation corresponds to the flexible-price allocation characterized by a zero labor wedge (panel g). However, the accumulation of trade surplus resulting from the monetary policy stimulus leads to a higher NFA position and higher levels of consumption relative to the pre-tariff levels.[14]

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 $\tau_0 = 10\%$ and $\rho = 0.976$, so that the half-life of the shock is 4 years. Figure E.2 presents the results.

When tariffs are temporary, households anticipate that the cost of consuming imported

[13] The original "Liberation Day" announcement set higher tariffs for several countries, which remain on hold, with the exception of China. We examine below the anticipation effects of a tariff policy that is expected to be enacted in the future. Our analysis could also be extended to allow for differences in tariffs across both countries and goods. See Ignatenko, Lashkaripour, Macedoni and Simonovska (2025) and Kalemli-Özcan et al. (2025) for other quantitative calibrations of Trump liberation day policies.

[14] Razin and Svensson (1983) is an early paper studying tariffs in an intertemporal framework. They show that temporary tariffs can affect capital flows and break Lerner symmetry, while permanent tariffs do not. In our model, permanent tariffs leave capital flows unchanged under a look-through policy but affect them under optimal monetary policy. See Aguiar, Amador and Fitzgerald (2025) and Itskhoki and Mukhin (2025) and Costinot and Werning (2025) for recent studies examining the connection between tariffs and capital flows.

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, any temporary shock has permanent effects on the NFA position, resulting in different long-run allocations. Notice that the case of a temporary tariff differs from a markup shock in that, the optimal monetary policy induces both inflation and a positive output gap (or a negative labor wedge, as can be seen in panel g). 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 now study the effects of announcing the introduction of tariffs at a future date (i.e., a "news shock" to tariffs). We assume that tariffs are announced at $t = 0$, implemented at $t = 4$, and remain constant thereafter.[15] Figure E.3 presents the results of this simulation. The tariff announcement leads to a trade deficit and a decrease in the NFA position, as agents increase their consumption of foreign goods before the price hike occurs. We 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 but relatively softer compared to the unanticipated case.

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, the production function is given by $y_{jt} = \ell_{jt}^{1-\nu} x_{jt}^{\nu}$, and the country's budget

[15]It is possible to extend the analysis by considering a uncertainty about whether the tariff will be introduced.

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.

The firm's problem differs from the one described in (5) in that the firm now has a choice about the use of alternative factors of production, labor, and inputs. Moreover, the marginal cost now depends on both wages and the price of imported inputs, inclusive of tariffs (see Appendix B for details). Consequently, tariffs raise the marginal cost of production and lower output for given monetary policy. However, the core insight from our baseline carries over: tariffs induce firms to perceive an inefficiently high cost of imports, which the monetary authority counteracts by stimulating the economy.

Figure 2 presents the results of a permanent tariff that applies to both consumption goods and inputs.[16] We calibrate the output elasticity with respect to imported inputs to match that half of imports correspond to intermediate inputs, which results in $\nu = 0.39$ (and recalibrate ω to continue to match the import-tradable GDP ratio). As the figure shows, under the look-through policy, output falls more than in the baseline (-8% vs. -4.5%) 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 on employment (panel b) exceeds the contraction in imported inputs (panel k), and thus GDP expands on impact (panel l).

Our modeling of the look-through policy in the version with imported inputs parallels the baseline model without inputs: we assume that the monetary authority maintains zero inflation in home goods, $\pi_t = 0$. However, unlike the case of tariffs on consumption goods, tariffs on inputs do not directly affect the CPI level. This implies that if tariffs apply only to imported inputs, the price of final consumption goods remains unchanged under a look-through policy. Accordingly, in this case, a look-through policy is equivalent to CPI inflation targeting, as illustrated in Figure B.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 B.3). In other words, divine coincidence holds

[16]Figures B.1 and B.2 present the cases where tariffs apply only to consumption goods or intermediate inputs.

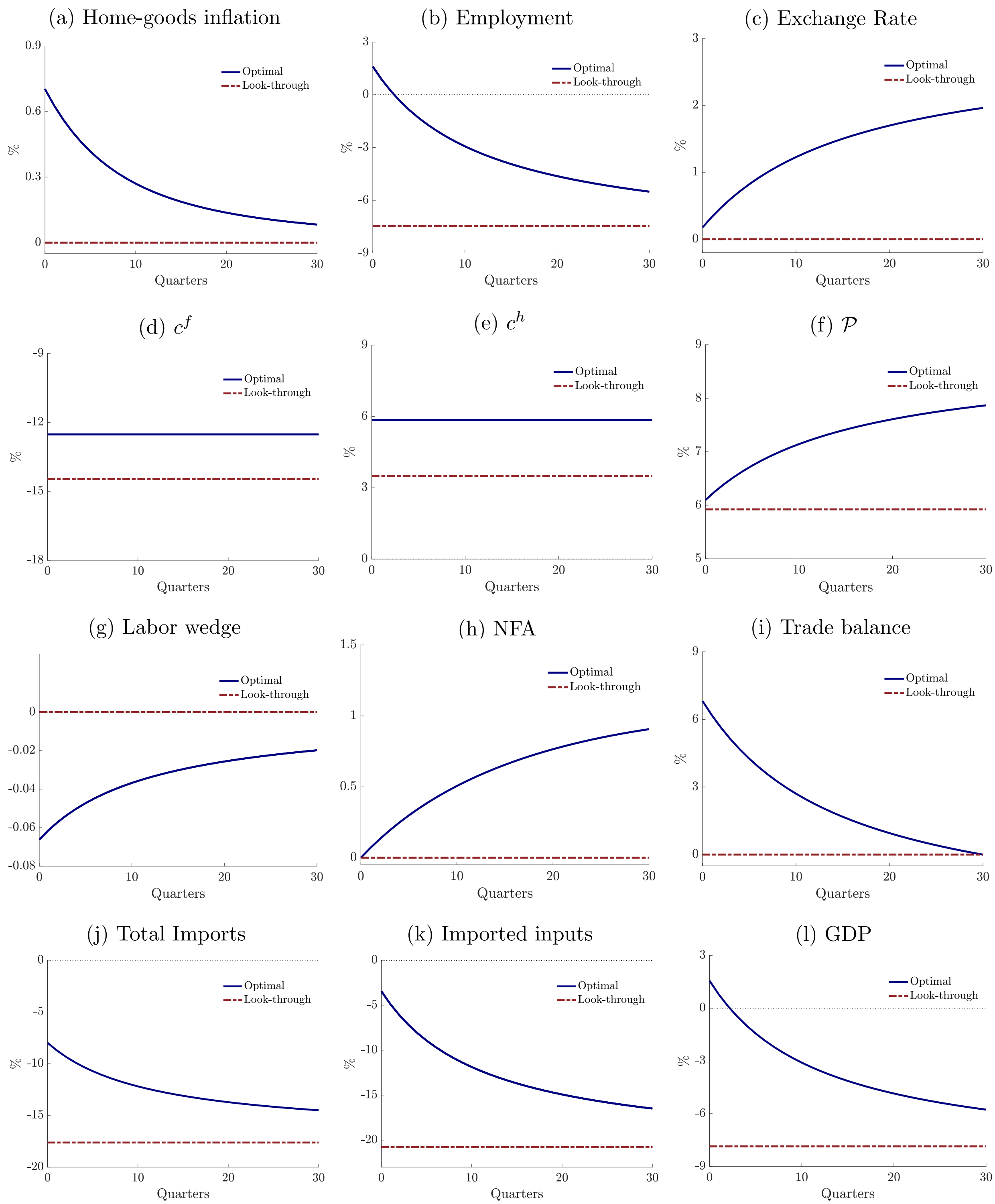


Figure 2: Response to a tariff shock in the model with imported inputs.

Notes: The tariff is imposed on imported consumption goods and intermediate inputs with $\tau_t = 10\%$ 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 price level are expressed in percentage deviation from the pre-tariff allocation.

in our model for TOT shocks to imported inputs. [17] 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 key 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 3 presents the results of this simulation. Consider first the look-through policy. As shown in panel (g), the labor wedge declines and employment rises, reflecting the higher wage subsidy and the lower associated markup distortion. As in previous experiments, domestic consumption c^h rises while foreign consumption c^f falls. Furthermore, the fact that the tariff is permanent combined with a neutral monetary stance implies that no changes in the exchange rate, trade balance, or net foreign assets take place.

We next turn to the optimal policy. To understand its response to the introduction of tariffs, 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. At the same time, the resulting increase in the wage subsidy partly offsets the need for further monetary stimulus, as it directly mitigates the markup distortion.

[17] 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.

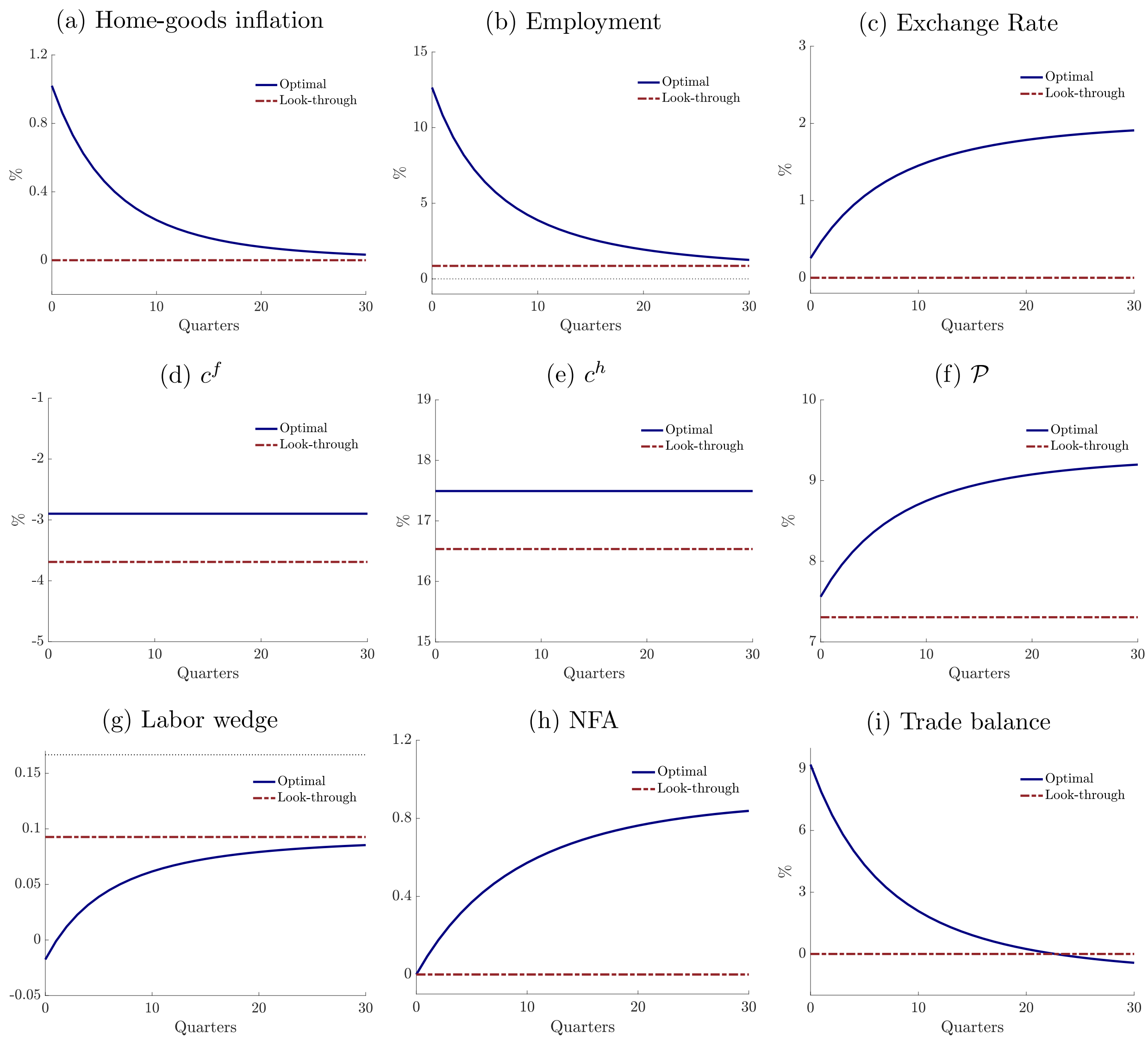


Figure 3: Response to a permanent tariff shock of 10% with a distorted steady state

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 and the NFA position are 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.

Figure 3 shows the deviations relative to the pre-tariff allocation. As we can see, the optimal monetary policy leads to a significant increase in employment and a rise in inflation. However, much of the initial stimulus reflects the pre-existing distortion in the steady state. Figure E.4 compares the optimal monetary policy with and without tariffs when starting from the distorted steady state. As the figure shows, inflation is slightly lower in the presence of a tariff, owing to the expansionary effect of the reduced labor tax.

5.3 Endogenous Terms of Trade

In our baseline model, the international 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.

Foreign demand for the home good follows

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

where A captures an overall global demand for domestic goods and $\theta > 1$ is the export demand elasticity. Following Galí and Monacelli (2005), this isoelastic demand schedule is derived from an environment with a continuum of small open economies where the foreign good is a composite of goods produced in the rest of the world (see Appendix C). Notice that our baseline model is a particular case where $\theta = \infty$.

Notice that from the perspective of the small open economy, a positive tariff is now optimal, as emphasized by Corsetti and Pesenti (2005) and Benigno and Benigno (2003). At a steady state with zero trade balance, the optimal tariff is given by

$$\tau^o = \frac{1}{\theta - 1} \tag{38}$$

When the tariff is set at this level, implementing the flexible price allocation becomes optimal. 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 our baseline model.

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

$$\wp = -\left[1 + \frac{\theta - 1 + \gamma}{\theta}\frac{c^h}{pc^f}\right]^{-1}\frac{\Delta\tau}{1+\tau^o} < 0 \tag{39}$$

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.[18] Figure C.1 presents the optimal response to a tariff shock of 10% tariff in excess of the optimal level (which is $\tau^o = 11.1\%$). Compared to the baseline, the monetary

[18] 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).

authority still stimulates the economy, though to a lesser extent because now the monetary authority internalizes that a higher output of home goods worsens the terms of trade.[19]

The key takeaway is that as in our baseline model, the optimal policy is to stimulate the economy because households do not internalize that by spending more on imports, this raises the tariff revenue and aggregate income for all households.

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 0.34% under the look-through policy. Moreover, optimal policy improves welfare by 0.014% relative to the look-through policy. The extension with intermediate inputs reveals that the welfare costs of tariffs become much larger when tariffs apply to inputs. Likewise, the gains from optimal policy become more substantial.

Table 2: Welfare Implications

	Gains Optimal Policy	Losses from Tariffs	
		Optimal Policy	Look-through
Baseline	0.014	0.32	0.34
Anticipated tariffs	0.012	0.33	0.34
Temporary tariffs	0.003	0.086	0.09
Endogenous TOT	0.009	0.23	0.24
Model w/ imported inputs			
Tariffs on c and x	0.31	0.78	1.10
Tariffs on c	0.03	0.30	0.33
Tariffs on x	0.16	0.38	0.55

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

[19] Appendix C provides additional simulations. Note that the result on the equivalence between a TOT shock and a tariff with wasted revenue—as stated in Proposition 3—still applies. To see this, note that a tariff shock with wasted revenue acts as an exogenous downward shift in export demand (37), effectively redefining $A = A/(1+\tau)$. In terms of optimal policy, however, due to the terms of trade externality, the optimal monetary policy is no longer targeting PPI inflation. Figure C.3 shows that the optimal policy turns contractionary in response to a TOT shock or an increase in tariffs with *wasted revenue*, starting from a zero tariff. The fact that optimal policy turns contractionary when the tariff revenue is wasted underscores the role of the fiscal externality in rationalizing an expansionary monetary response to tariffs, regardless of whether terms of trade are exogenous or endogenous.

Welfare under distorted steady state. We highlight that 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 4 illustrates, for a range of parameter values, tariffs can indeed raise welfare.

The fact that optimal tariffs are positive (even absent a terms-of-trade externality) implies that it is optimal to tax home and foreign goods at different rates. Why does the Diamond and Mirrlees principle of optimal taxation not apply in this environment? When the labor subsidy is zero, the economy operates with a positive steady-state markup. In this setting, even though tariffs distort relative consumption, they may improve welfare by lowering the steady-state markup. In particular, starting from zero tariffs, small increases generate only modest welfare costs while delivering strictly positive gains by reducing the labor wedge. Proposition 6 formally establishes this result under look-through policy.

Proposition 6 (Welfare gain from small tariffs)**.** *Consider an economy with a constant tariff and a labor subsidy given by* (36)*. Then, starting from zero tariffs, a marginal increase in the tariff raises welfare.*

Figure 4 also shows that when the elasticity of substitution between home and foreign goods is low and imports represent a small fraction of aggregate demand, tariffs are more likely to raise welfare.[20] Intuitively, when either the elasticity is low or the share of imports in final consumption is small, a tariff induces only a modest distortion in relative consumption. In this case, the reduction in the labor wedge made possible by tariff revenue outweighs the distortionary effects of the tariff.

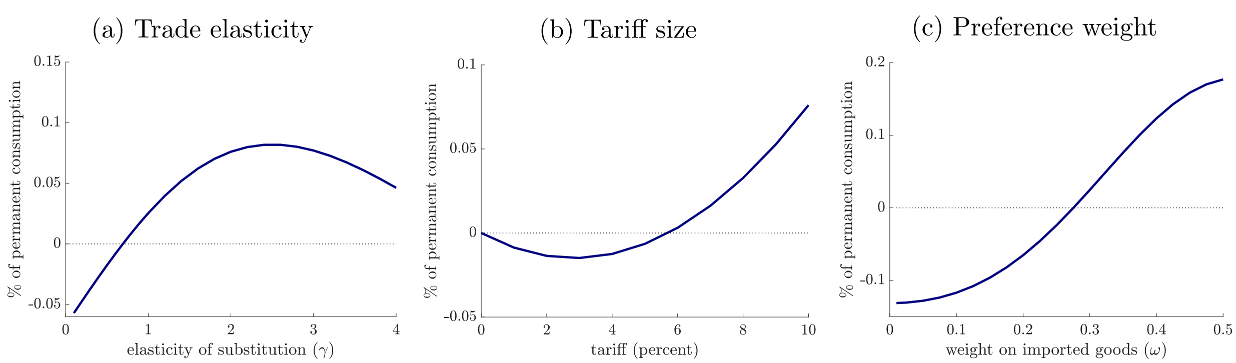


Figure 4: Welfare loss from tariffs under optimal policy when steady state is distorted

Note: The initial allocation has an 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.

[20]The welfare losses from tariffs under look-through policy follow the same pattern as under optimal policy.

5.5 CPI Targeting

Our analysis has taken as a benchmark a "look-through policy," in which the monetary authority targets PPI inflation, and has shown how monetary policy can improve upon this benchmark. In practice, however, targeting CPI inflation is a more common policy for central banks. Given the inflationary effects of tariffs, we argue below that targeting CPI inflation requires a tightening of monetary policy, resulting in worse macroeconomic outcomes relative to a policy of targeting PPI inflation.

We consider the following policy rule

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

where $\bar{e}_t$ is the natural level of the exchange rate (i.e., the one that would implement the flexible price allocation) and $\phi_\pi > 0$ captures the responsiveness of the nominal rate to the level of inflation When $\phi_\pi = 0$, the rule corresponds to the look-through policy and for $\phi_\pi \to \infty$, the rule corresponds to a strict CPI targeting.

Appendix D presents simulations comparing the optimal policy to the CPI-targeting rule with $\phi_\pi = 1.5$. As the figures show, a policy of CPI targeting induces an appreciation of the exchange rate, as the monetary authority seeks to stabilize the price level. The economy experiences a recession and a trade deficit, as households borrow to smooth consumption in response to the contractionary policy. Table D.1 reports the welfare implications of tariffs for different values of ϕ_π. The results show that the stronger the central bank's response to deviations of CPI inflation from its target, the larger 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. In this paper, we develop a simple theory to characterize the macroeconomic effects of tariffs and the optimal monetary policy response. Tariffs create a fiscal externality by inefficiently reducing private incentives to import foreign goods, and the optimal monetary response is to stimulate aggregate income to counteract this distortion. We show that the optimal policy is stimulative, leading to a positive output gap and an increase in inflation above and beyond the direct effects of tariffs on imported goods. This result holds across a range of environments, including when tariffs apply to consumption goods or intermediate inputs, when the shocks are temporary or permanent, and when terms of trade are exogenous or endogenous. Our analysis also highlights that tariffs can either expand or contract employment depending on the intra- and intertemporal elasticities of substitution and the magnitude of the tariff, but that optimal policy always raises employment relative to a look-through policy. Moreover, we show that when tariffs are introduced starting from a positive steady-state markup, with tariff revenue used to subsidize labor, monetary policy remains expansionary, the inflationary effects are mitigated, and welfare can increase for small tariffs.

We conclude by emphasizing that our model is intentionally stylized, abstracting from several important considerations, including trade wars and broader strategic and geopolitical factors. Incorporating these dimensions and analyzing their implications for the optimal conduct of monetary policy remains an important avenue for future research.

References

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

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

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

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

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

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

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

_ , _ , and _ , "Trade Wars and the Optimal Design of Monetary Rules," 2024. NBER Working Paper No. 32451.

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

Bagwell, Kyle and Robert W. Staiger, "The Design of Trade Agreements," in Kyle Bagwell and Robert W Staiger, eds., *Handbook of Commercial Policy*, Vol. 1, Elsevier, 2016, pp. 435–529.

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

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

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

Benigno, Gianluca and Pierpaolo Benigno, "Price Stability in Open Economies," *The Review of Economic Studies*, 2003, *70* (4), 743–764.

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

Bergin, Paul R and Giancarlo Corsetti, "Beyond competitive devaluations: The monetary dimensions of comparative advantage," *American Economic Journal: Macroeconomics*, 2020, *12* (4), 246–286.

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

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

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

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

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

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

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

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

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

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

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

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

Corsetti, Giancarlo and Paolo Pesenti, "International Dimensions of Optimal Monetary Policy," *Journal of Monetary Economics*, 2005, *52* (2), 281–305.

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

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

Cuba-Borda, Pablo, Albert Queralto, Ricardo Reyes-Heroles, and Mikaël Scaramucci, "Trade Costs and Inflation Dynamics," 2025. FRB of Dallas Working Paper.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Itskhoki, Oleg and Dmitry Mukhin, "Can a Tariff Be Used to Close a Long-Run Trade Deficit?," 2025. Mimeo, Harvard.

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

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

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

Keynes, John Maynard, "The general theory of employment," *Quarterly Journal of Economics*, 1937, *51* (2), 209–223.

Kimball, Miles and Matthew Shapiro, "Labor supply: are the income and substitution effects both large or both small," 2008. NBER Working Paper No. 14208.

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

Kugler, Adriana, "Inflation Dynamics and the Phillips Curve," 2025. At Ec10b Principles of Economics Lecture, Harvard University.

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

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

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

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

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

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

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

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

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

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

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

Woodford, Michael, *Interest and prices*, Princeton University Press, 2003.

— , *Interest and prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, 2011.

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

A Proof

A.1 Proof of Proposition 2

Proof. Using $\beta R^* = 1$, (14)-(17), we have that

$$c_t^h = c^h, \tag{A.1}$$

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

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[(\omega\Theta_\tau)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}}\left(c^h\right)^{\frac{1}{\sigma}}\ell_t^\psi - 1\right] + \beta\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \tag{A.3}$$

$$b_0 = \sum_{t=0}^{\infty}\beta^t\left[c^h + pc^f - \ell_t\right] \tag{A.4}$$

Note that to obtain (A.1), we first use (16) to get $u_h(c_t^h, c_t^f) = \omega(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\sigma(\gamma-1)}}(c_t^h)^{-\frac{1}{\sigma}}$. Plugging it into (17), that is $u_h(c_t^h, c_t^f) = u_h(c_{t+1}^h, c_{t+1}^f)$, we arrive at $c_t^h = c_{t+1}^h$ for all t.

Under the look-through policy $\pi_t = 0$ for all t and the allocation is

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

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

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

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

$$\max_{c^h,\ell}\frac{(\omega\Theta_\tau)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}}}{1-\sigma^{-1}}\left(c^h\right)^{1-\frac{1}{\sigma}} - \omega\frac{\ell^{1+\psi}}{1+\psi} \tag{A.5}$$

subject to

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

Denoting by λ the Lagrange multiplier on (A.6), the first-order condition for ℓ_t and c^h are respectively given by

$$\omega \ell_t^{\psi} = \lambda, \quad \text{and} \quad (\omega\Theta_\tau)^{\frac{\gamma(\sigma-1)}{\sigma(\gamma-1)}} \left(c^h\right)^{-\frac{1}{\sigma}} = \lambda \frac{\Theta_\tau + \tau}{1+\tau}, \tag{A.7}$$

which imply that ℓ is constant. Using (A.6) and (A.7), we arrive at

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

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

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

In addition, given that $\Theta_\tau > 1$, we have that

$$\frac{1+\tau}{1+\Theta_\tau^{-1}\tau} > 1,$$

Using this inequality, we obtain $\ell > \ell^{look}$, $c^h > c^{h,look}$ and $c^f > c^{f,look}$. Finally, we use (A.3) and (A.7), to get $\ell_{t+1} = \ell, c_t^h = c^h$. Solving for a constant level of inflation $\pi_t = \pi$, we obtain

$$\begin{aligned}(1+\pi)\pi &= \frac{\varepsilon}{\varphi}\sum_{t=0}^{\infty}\beta^t \left[(\omega\Theta_\tau)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c^h\right)^{\frac{1}{\sigma}} \ell^{\psi} - 1\right] \\ &= \frac{\varepsilon}{\varphi(1-\beta)} \frac{(\Theta_\tau - 1)\,\tau}{\Theta_\tau + \tau} > 0 \end{aligned} \tag{A.8}$$

where the inequality follows from $\Theta_\tau > 1$. Given that a root with $\pi < -1$ is not feasible, the optimal policy therefore implies $\pi > 0$. □

A.2 Proof of Corollaries 1 and 2

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

A.3 Proof of Proposition 3

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

$$\max_{\{c^h,c^f,\ell_t,\pi_t\}} \sum_{t=0}^{\infty} \beta^t \left[u\left(c^h, c^f\right) - \omega \frac{\ell_t^{1+\psi}}{1+\psi} \right], \tag{A.9}$$

subject to

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi}\left[\frac{\omega \ell_t^{\psi}}{u_h(c^h,c^f)} - 1\right] + \beta \frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1}, \qquad [\eta_t] \tag{A.10}$$

$$c^f = \left[\frac{1-\omega}{\omega p(1+\tau)}\right]^{\gamma} c^h, \qquad [\xi] \tag{A.11}$$

$$b_0 = \sum_{t=0}^{\infty} \beta^t \left[c^h + p(1+\tau)c^f - \left(1 - \Upsilon \frac{\varphi}{2}\pi_t^2\right)\ell_t \right], \qquad [\lambda] \tag{A.12}$$

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

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

$$\ell = c^h + p(1+\tau)c^f \iff \ell = \Theta_\tau c^h \tag{A.14}$$

$$c^f = \left[\frac{1-\omega}{\omega p(1+\tau)}\right]^{\gamma} c^h \iff c^f = \frac{\Theta_\tau - 1}{p(1+\tau)} c^h, \tag{A.15}$$

which yield (25). Note from (A.13) and (A.10) that $\pi_t = 0$ for all t.

□

A.4 Proof of Proposition 4

We focus here on the case where $\psi \to 0^+$ which imply $\wp = 1 - \frac{\omega}{u_h(c_t^h, c_t^f)}$ is constant.

The solution to the Ramsey optimal policy problem is given by the optimality conditions (30)-(34) along with the implementability constraints (29)-(27). First, we use (29) and (33) to rewrite (32) as

$$\omega = \left[1 - \frac{1}{1+2\pi_t}\frac{\varphi}{2}\pi_t^2 + \left(\beta\frac{\ell_{t+1}}{\ell_t}(1+\pi_{t+1})\pi_{t+1} - (1+\pi_t)\pi_t\right)\frac{\eta_t}{\ell_t}\right]\lambda \tag{A.16}$$

Combining (30) and (31), we get

$$\lambda = \Xi \frac{\Theta_\tau \left(1+\tau\right)}{\Theta_\tau + \tau} u_h \left(c_t^h, c_t^f\right), \tag{A.17}$$

$$\text{where} \quad \Xi \equiv 1 - \frac{\varepsilon}{\varphi\sigma} \frac{\wp(1-\wp)}{\Theta_\tau c^h} \sum_{t=0}^{\infty} (1-\beta)\beta^t \eta_t,$$

and from (33) we have

$$\frac{\eta_t}{\ell_t} = \varphi\lambda \sum_{k=0}^{t} \frac{\pi_k}{1+2\pi_k} \tag{A.18}$$

A first order approximation of (A.16) around $\pi_t = 0$ yields $\lambda = \omega$ and to a first-order $\Xi = 1$. To see why to a first-order $\Xi = 1$, note from (29) that at $\pi_t = 0$ we have $\wp_t = 0$. We then plug $\lambda = \omega$ and $\Xi = 1$ into (A.17) to arrive at

$$\omega = \frac{\Theta_\tau(1+\tau)}{\Theta_\tau + \tau} u_h \left(c_t^h, c_t^f\right) \quad \text{which implies that} \quad \wp = -\tau \frac{\Theta_\tau - 1}{\Theta_\tau + \tau} < 0$$

A.5 Proof of Proposition 5

The monetary authority's problem is given by

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

subject to

$$c_t^h + p_t c_t^f + \frac{b_{t+1}}{R^*} = b_t + \left[1 - \Upsilon \frac{\varphi}{2} \pi_t^2 \right] \ell_t, \tag{A.19}$$

$$(1+\pi_t)\pi_t = \frac{\varepsilon}{\varphi} \left[\frac{\omega\, \ell_t^\psi}{u_h(c_t^h, c_t^f)} - 1 \right] + \frac{1}{R^*} \frac{\ell_{t+1}}{\ell_t} (1+\pi_{t+1})\pi_{t+1}, \tag{A.20}$$

$$\frac{1-\omega}{\omega} \left(\frac{c_t^h}{c_t^f} \right)^\gamma = p(1+\tau_t), \tag{A.21}$$

$$u_h(c_t^h, c_t^f) = \beta R^* u_h(c_{t+1}^h, c_{t+1}^f). \tag{A.22}$$

$$p_t = A \left(\ell_t - c_t^h\right)^{\frac{1}{\theta}} \tag{A.23}$$

Under the assumption that $\Upsilon = 0$, π_t only enters (A.20). As a result, (A.20) can be dispensed from the Ramsey planner's problem and used to back out π_t. Then, under the assumption that $\beta R^* = 1$, τ is constant and $b_0 = 0$, we have that c^h, c^f and ℓ are constant. We can then rewrite the monetary authority's problem as

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

subject to

$$c^f = \left(\ell - c^h\right)^{-\frac{\gamma}{\theta}} \left(\frac{1-\omega}{\omega A(1+\tau)}\right)^{\gamma} c^h \tag{A.24}$$

$$\ell = c^h + A(\ell - c^h)^{\frac{1}{\theta}} c^f \tag{A.25}$$

Denoting by ξ and λ the Lagrange multipliers on (A.24) and (A.25), the first order conditions for c^f, c^h and ℓ are given by

$$u_f(c_t^h, c_t^f) - \xi = \lambda p_t \tag{A.26}$$

$$u_h(c^h, c^f) + \left[\frac{c^f}{c^h} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\right]\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{A.27}$$

$$\omega\left(\ell\right)^{\psi} + \frac{\gamma}{\theta}\frac{c^f}{\ell - c^h}\xi = \left[1 - \frac{1}{\theta}\frac{pc^f}{\ell - c^h}\right]\lambda \tag{A.28}$$

Combining (A.27) and (A.28), we obtain

$$1 - \frac{\omega\left(\ell\right)^{\psi}}{u_h(c^h, c^f)} = -\frac{c^f}{c^h u_h(c^h, c^f)}\xi \tag{A.29}$$

Note that the left hand side of (A.29) is the labor wedge $\wp \equiv 1 - \frac{\omega \ell^{\psi}}{u_h(c^h, c^f)}$. Next, combining (A.26) and (A.27) and using (A.25), we get

$$\begin{aligned}\xi &= \left[\tau - \frac{1}{\theta}(1+\tau)\right]\left[\frac{\theta-1}{\theta} + \frac{pc^f}{c^h} + \frac{\gamma}{\theta}\right]^{-1} u_h(c^h, c^f) \\ &= \frac{\Delta_\tau}{1+\tau^o}\left[\frac{\theta - 1 + \gamma}{\theta} + \frac{pc^f}{c^h}\right]^{-1} u_h\left(c^h, c^f\right)\end{aligned} \tag{A.30}$$

where the second equality uses $\tau = \tau^o + \Delta\tau$ with $\tau^o \equiv \frac{1}{\theta - 1}$ defined in (38). Then, plugging (A.30) into (A.29), we arrive at

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

which corresponds to (39).

A.6 Proof of Proposition 6

Under look-through (flexible price allocation), the competitive equilibrium in an economy with a constant tariff and a labor subsidy (36) is given by

$$\ell_t = c^h + pc^f \tag{A.31}$$

$$c^f = \left(\frac{1-\omega}{\omega p\,(1+\tau)}\right)^{\gamma} c_t^h \tag{A.32}$$

$$\frac{W_t}{P_t^h} = \frac{\omega \ell_t^{\psi}}{u_h\,(c^h, c^f)} \tag{A.33}$$

$$P_t^h = \frac{\varepsilon}{\varepsilon - 1}\,(1 - s_t)\, W_t \tag{A.34}$$

$$p_t \tau_t c_t^f = s_t \frac{W_t}{P_t^h} \ell_t \tag{A.35}$$

Using (A.33) and (A.35) to substitute for $\frac{W_t}{P_t^h}$ and s_t, we can rewrite (A.31), (A.32), (A.34) as

$$c^h = \frac{1+\tau}{\Theta_\tau + \tau}\ell_t \tag{A.36}$$

$$c^f = \frac{\Theta_\tau - 1}{p\,(1+\tau)} c_t^h \tag{A.37}$$

$$(\omega \Theta_\tau)^{\frac{\gamma-\sigma}{\sigma(\gamma-1)}} \left(c_t^h\right)^{\frac{1}{\sigma}} (\ell_t)^{\psi} = \frac{\Theta_\tau - 1}{1+\tau}\frac{\tau c_t^h}{\ell_t} - \frac{\varepsilon - 1}{\varepsilon} \tag{A.38}$$

where recall that $\Theta_\tau \equiv 1 + \left(\frac{1-\omega}{\omega}\right)^{\gamma} (p\,(1+\tau))^{1-\gamma}$. From (A.38), we obtain that

$$\ell(\tau) = \left[(\omega\Theta_\tau)^{\frac{\sigma-\gamma}{\gamma-1}} \frac{\Theta_\tau + \tau}{1+\tau} \left(\frac{\Theta_\tau - 1}{\Theta_\tau + \tau}\tau + \mathcal{M}^{-1}\right)^{\sigma}\right]^{\frac{1}{1+\sigma\psi}} \tag{A.39}$$

and

$$\left.\frac{d\ell(\tau)}{d\tau}\right|_{\tau=0} = \frac{1}{1+\sigma\psi}\frac{\sigma}{\varepsilon - 1}\frac{\Theta_\tau - 1}{\Theta_\tau}\ell(\tau) > 0 \tag{A.40}$$

Using (A.36) and (A.37), we can express welfare as

$$W(\tau) = \frac{1}{1-\beta}\left[\frac{1}{1-\frac{1}{\sigma}}\left((\omega\Theta_\tau)^{\frac{\gamma}{\gamma-1}}\frac{1+\tau}{\Theta_\tau + \tau}\right)^{1-\frac{1}{\sigma}} \ell\,(\tau)^{1-\frac{1}{\sigma}} - \frac{\omega}{1+\psi}\ell\,(\tau)^{1+\psi}\right] \tag{A.41}$$

Differentiating (A.41) with respect to τ we get

$$\left. W'(\tau)\right|_{\tau=0} = \frac{1}{1-\beta}\frac{\omega}{(\varepsilon-1)^2}\frac{\sigma}{1+\sigma\psi}\frac{\Theta_0 - 1}{\Theta_0}\ell^{1+\psi} > 0. \quad \square \tag{A.42}$$

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

Javier Bianchi and Louphou Coulibaly

B Extension with Imported Inputs

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

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

The government budget constraint satisfies

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

Combining the last two conditions with the households' budget constraint, we arrive to (35).

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

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

subject to

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

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

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

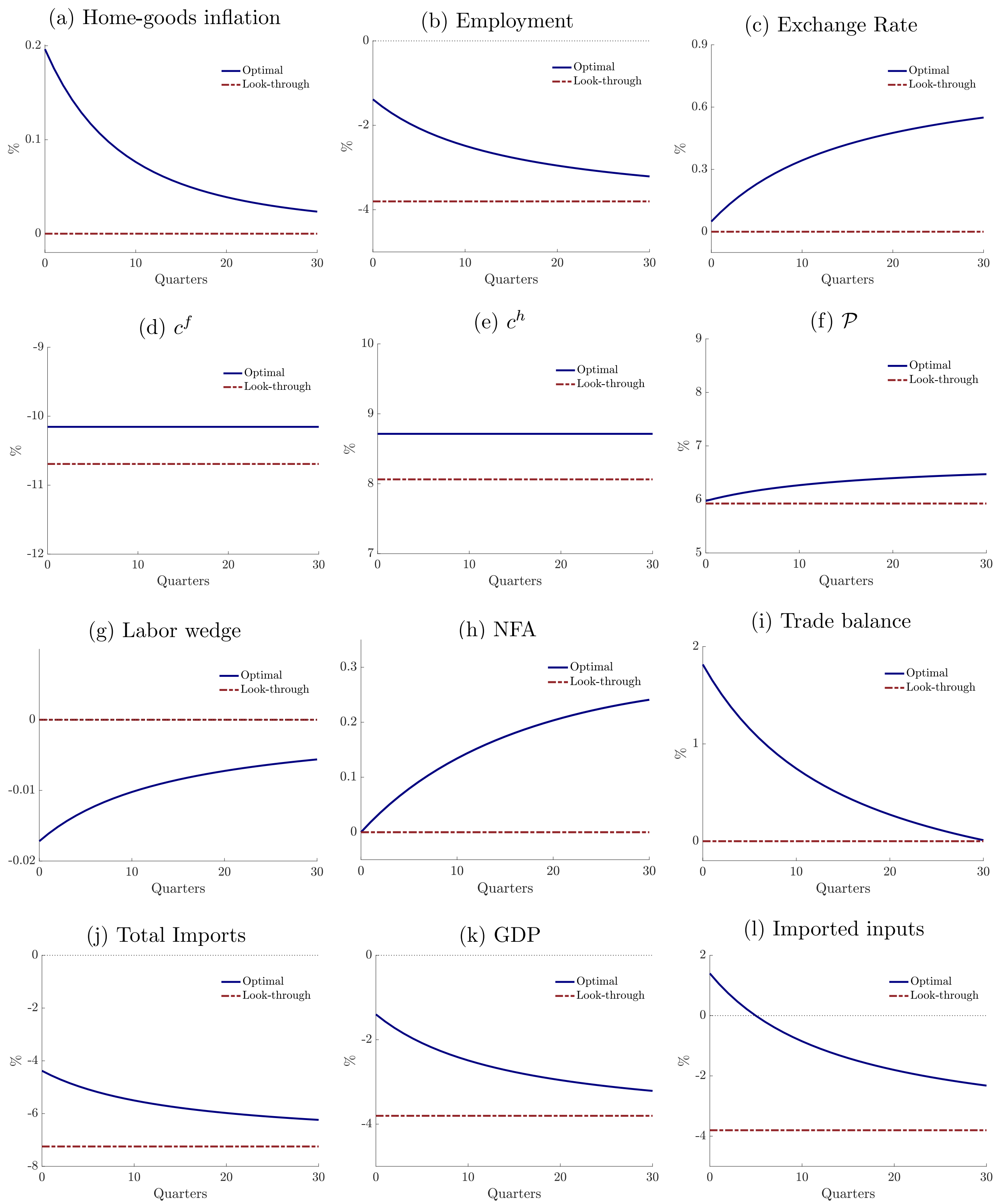
$$x_t^f = \frac{\nu}{1-\nu} \frac{c_t^h \; \ell_t^{\psi+1}}{p(1+\tau_t^x)}$$

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

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

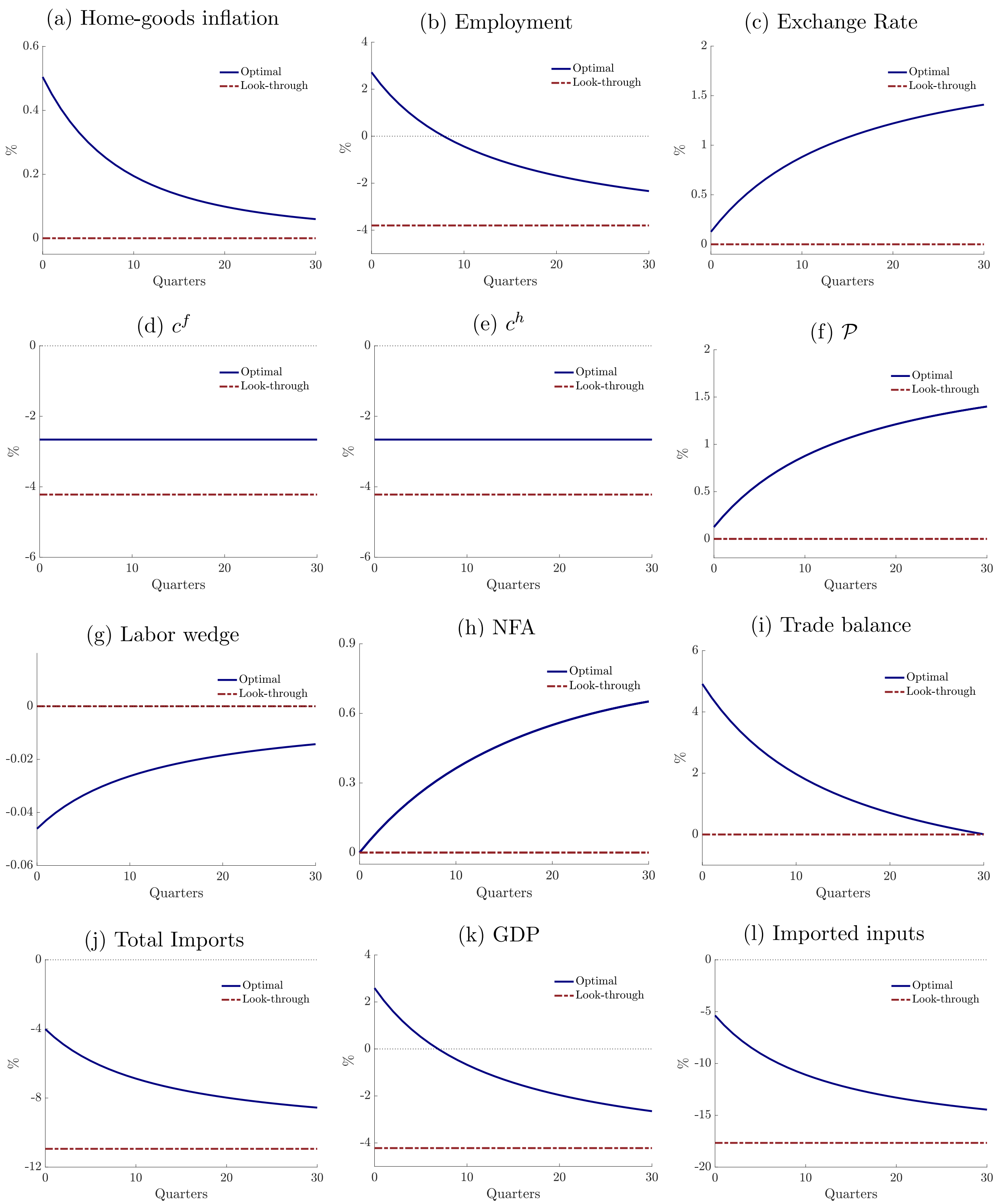
The simulation results of this policy problem are presented in Figures 2, B.1, B.2, and B.3.

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



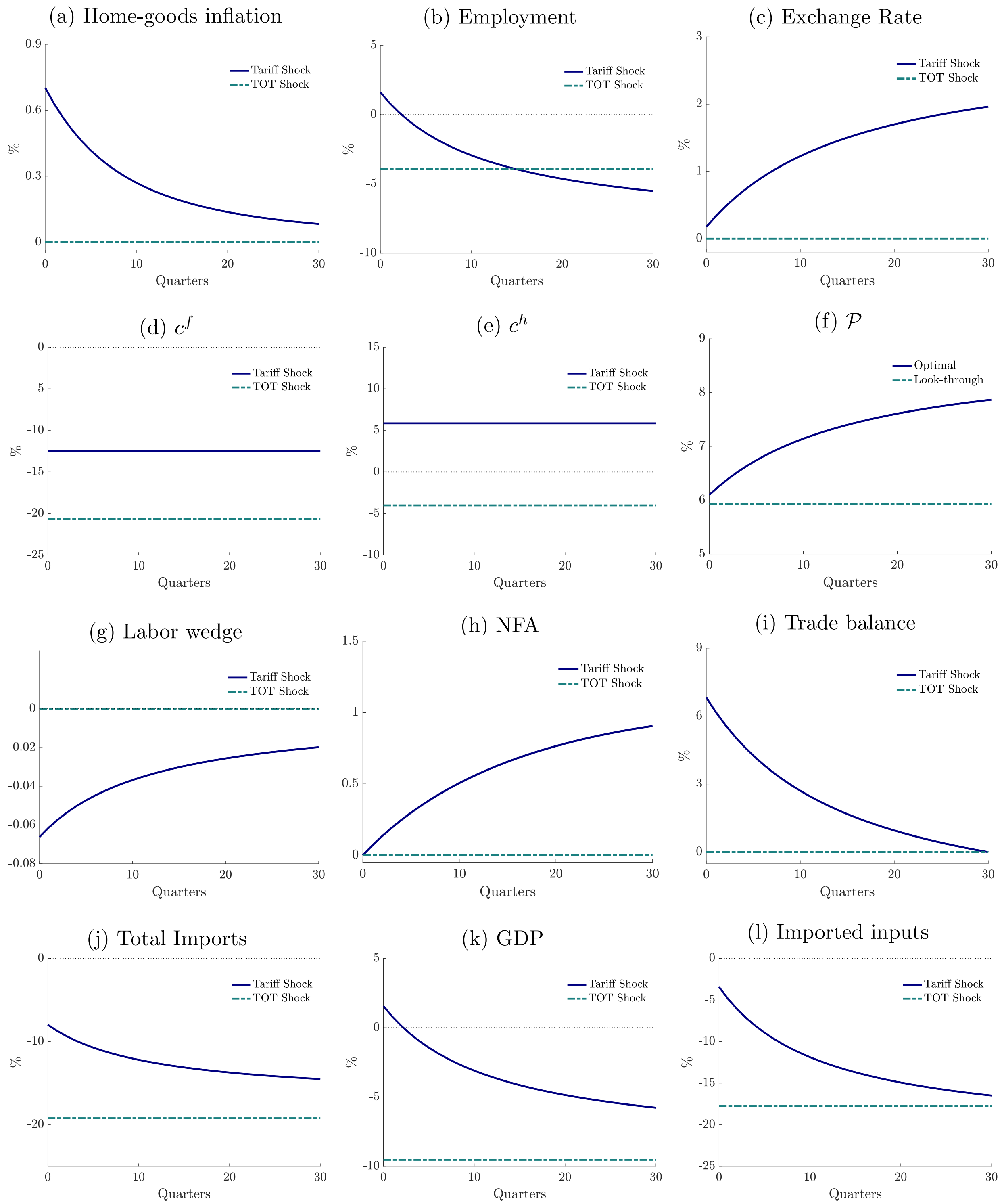
Notes: The tariffs are set to $\tau_t^c = 10\%$ and $\tau_t^x = 0$. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable price level are expressed in percentage deviation from the pre-tariff allocation.

Figure B.2: Tariff on foreign inputs



Notes: The tariffs are set to $\tau_t^x = 10\%$ 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 price level are expressed in percentage deviation from the pre-tariff allocation.

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



Notes: We assume a permanent $\tau = 10\%$ for the tariff and a permanent increase in p of 10% 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 price level are expressed in percentage deviation from the pre-tariff allocation.

C Extension with Endogenous Terms of Trade

We provide here more details on the derivation of the demand function (37). 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 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

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

Noting that all Foreign countries are symmetric and applying (B.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

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

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 (B.2) as

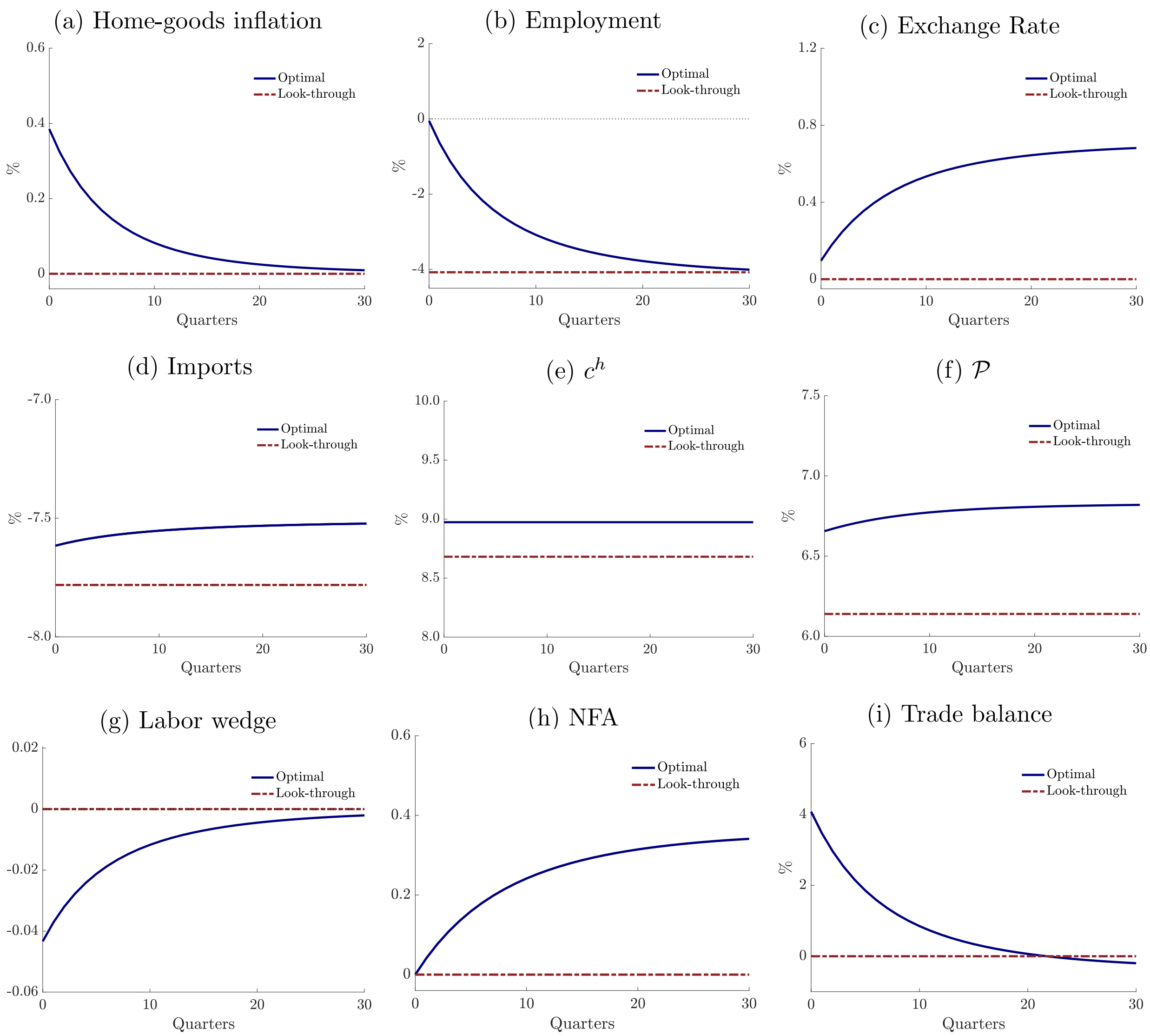
$$c_t^{h*} = (1-\omega)(p_t)^{\theta} c_t^*$$

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

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

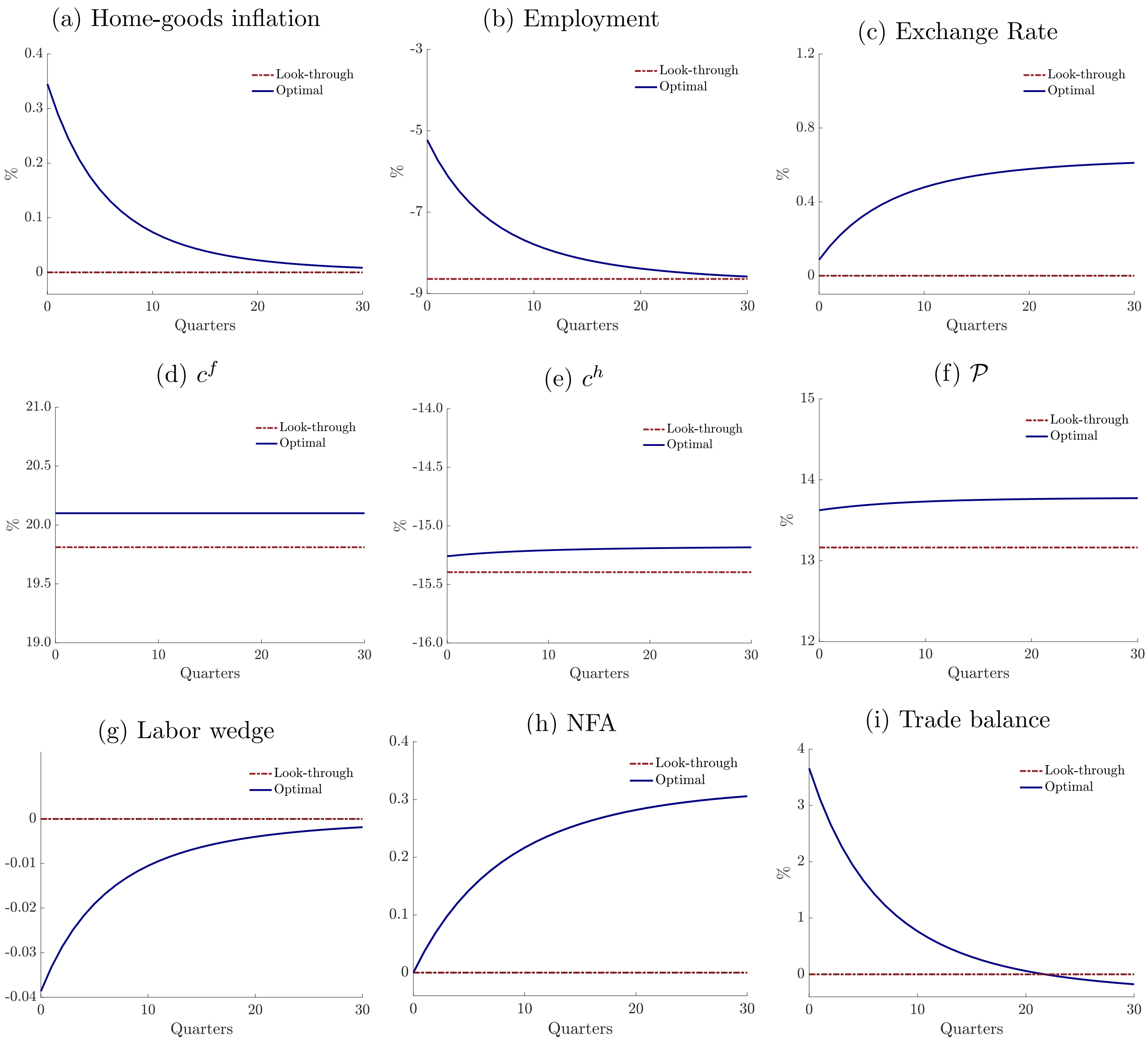
which corresponds to (37), and where $A \equiv [(1-\omega)c_t^*]^{-\frac{1}{\theta}}$ is an exogenous demand shifter.

Figure C.1: Simulations with endogenous terms of trade



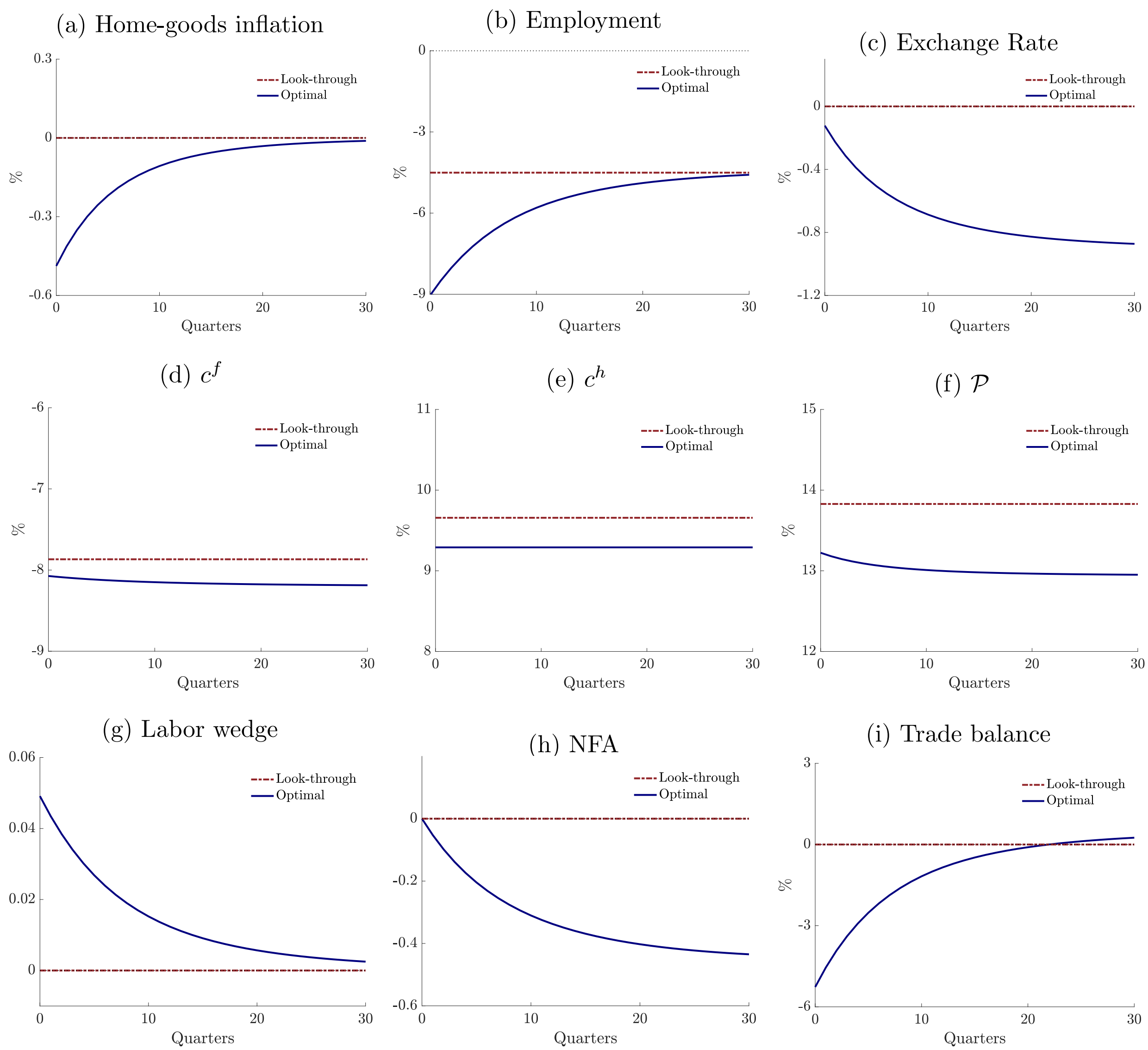
Notes: The figure displays the response to a permanent increase in tariffs of $\tau = 10\%$ starting from the optimal tariff. The relative price of imports is given by (37) and $\theta = 10$. Imports in panel (d) refers to the deviation of import spending $p_t c_t^f$ relative to the pre-shock allocation. 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 price level are expressed as percent deviation from the allocations before the shock.

Figure C.2: Impulse response to a 20% permanent increase in tariff



Notes: The figure presents the impulse response to a 20% tariff when the initial tariff is zero. See the note on Figure C.1 for further details.

Figure C.3: Simulations when tariff revenue is wasted



Notes: The figure presents the impulse response to a 20% tariff when the initial tariff is zero and tariff revenue is wasted. See the note on Figure C.1 for further details.

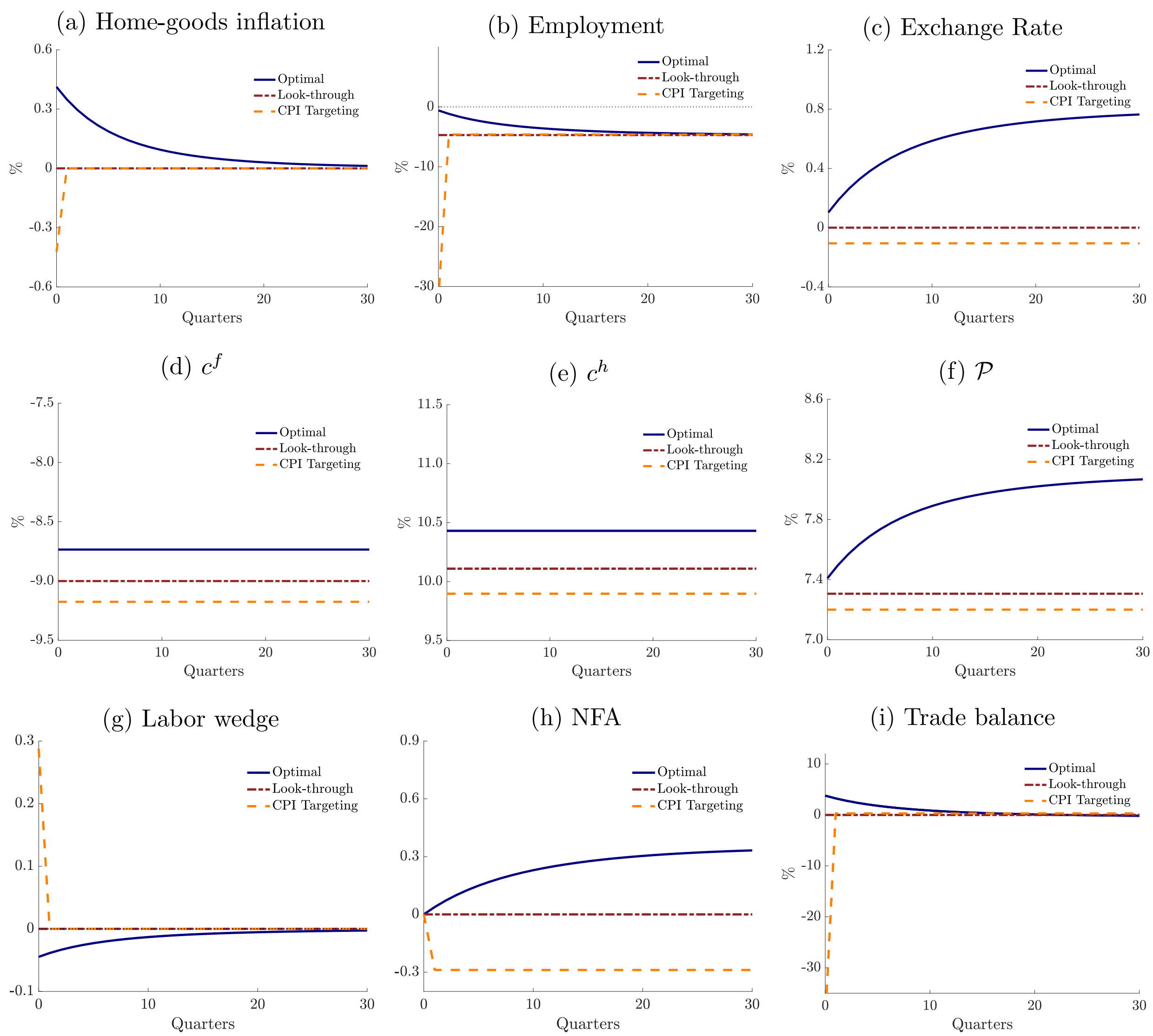
D Simulations under CPI Targeting

Table D.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	0.014	0.07	0.48	0.34	0.39	0.82
Anticipated tariffs	0.012	0.07	0.47	0.34	0.39	0.79
Endogenous TOT	0.009	0.02	0.05	0.24	0.26	0.28
Model w/ imported inputs						
Tariffs on c and x	0.31	0.42	0.79	1.10	1.21	1.58
Tariffs on c	0.03	0.12	0.50	0.33	0.42	0.81
Tariffs on x	0.16	0.16	0.16	0.55	0.55	0.55

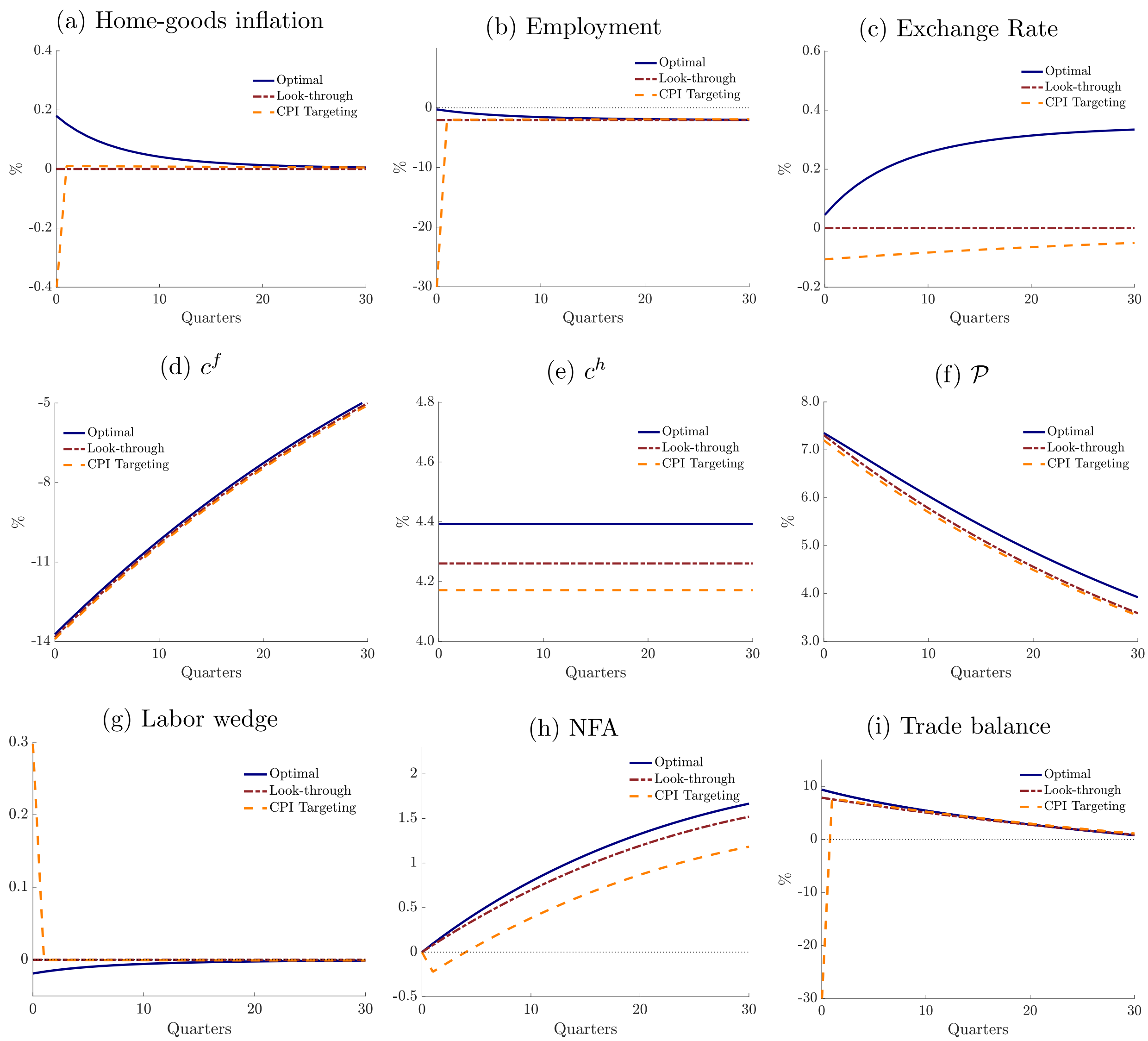
Note: Welfare corresponds to permanent consumption equivalence and is expressed in percentage.

Figure D.1: Baseline model with permanent tariff



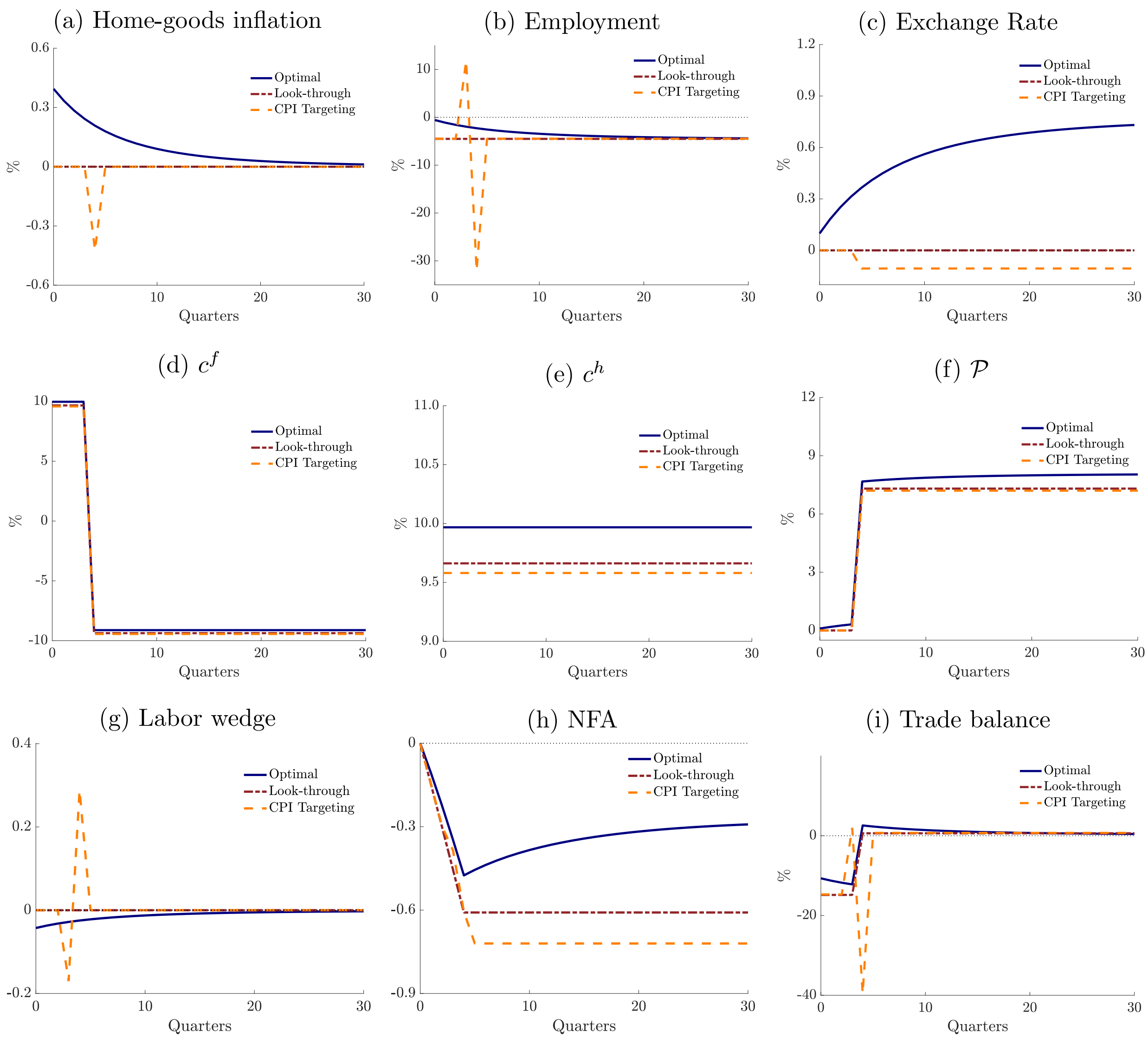
Notes: The tariff is set to $\tau_t = 10\%$ for all t. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable price level are expressed in percentage deviation from the pre-tariff allocation.

Figure D.2: Baseline model with temporary tariff



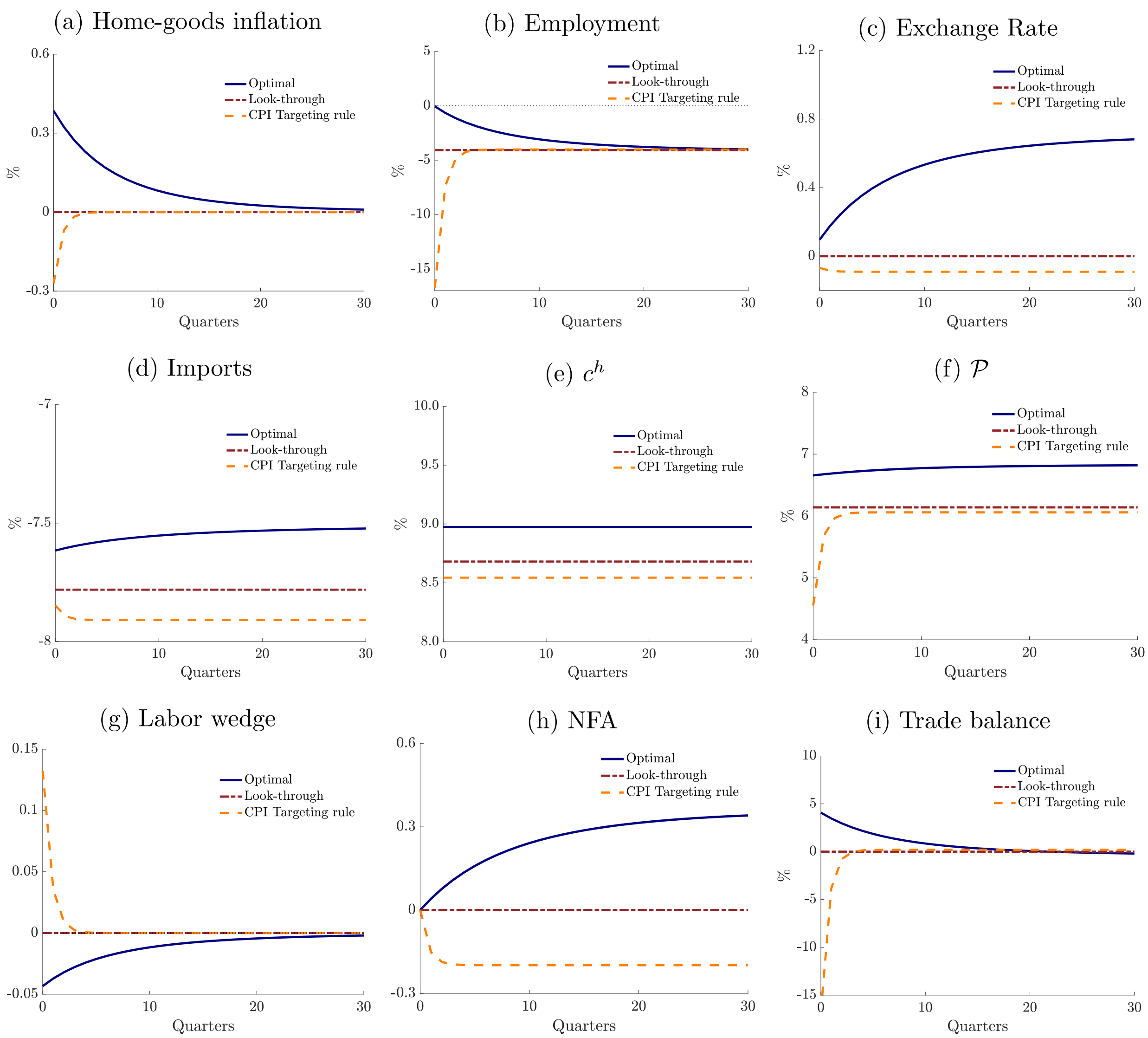
Notes: The tariff follows $\tau_t = \rho\tau_{t-1}$ with $\tau_t = 10\%$ and $\rho = 0.976$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure D.1 for further details.

Figure D.3: Baseline model with anticipated tariff



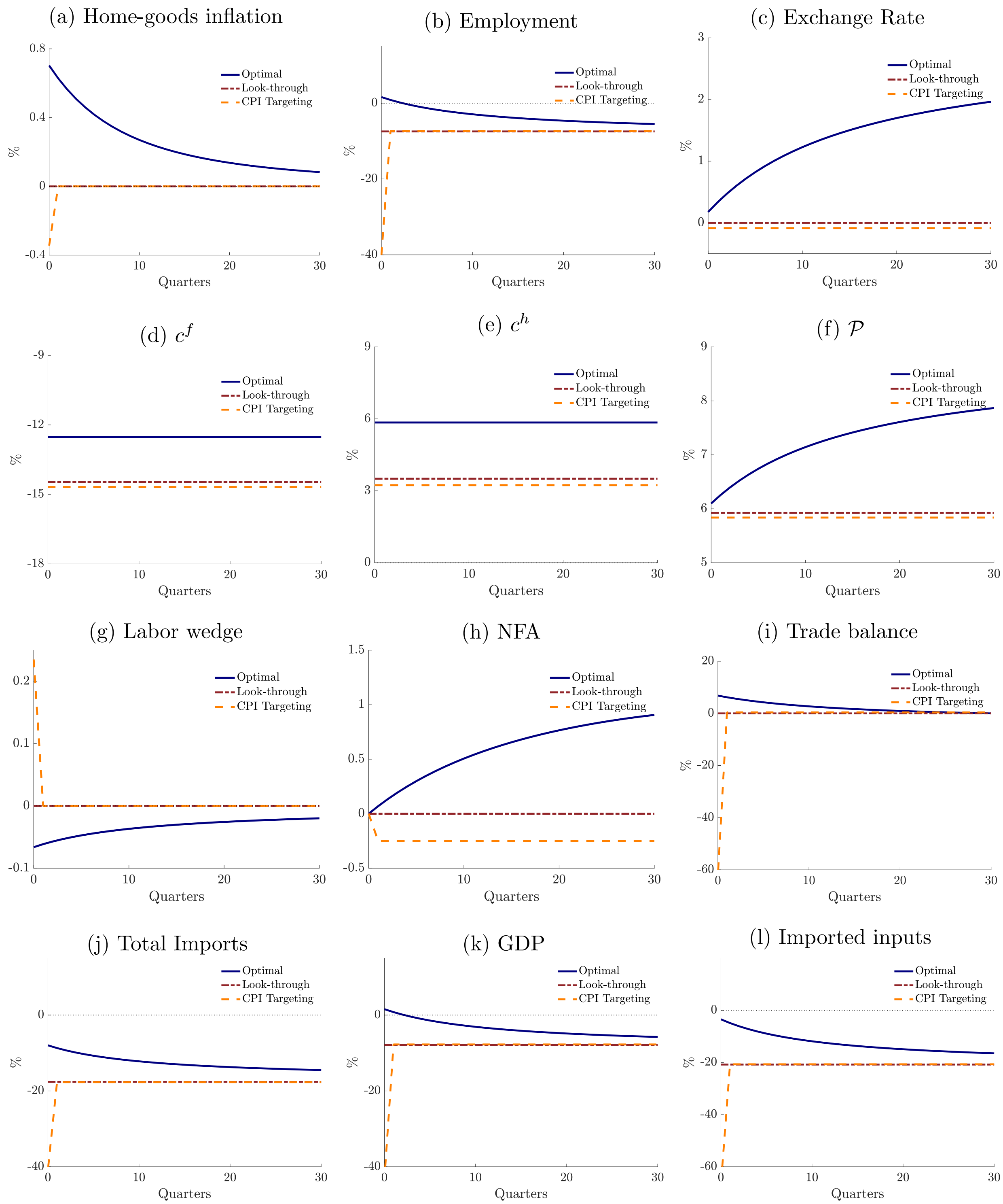
Notes: A permanent tariff of 10% is announced at $t = 0$ and imposed at $t = 4$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure D.1 for further details.

Figure D.4: Simulations with Endogenous Terms of Trade



Notes: The figure displays the response to a permanent tariff of $\tau = 10\%$ 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 D.1 for further details.

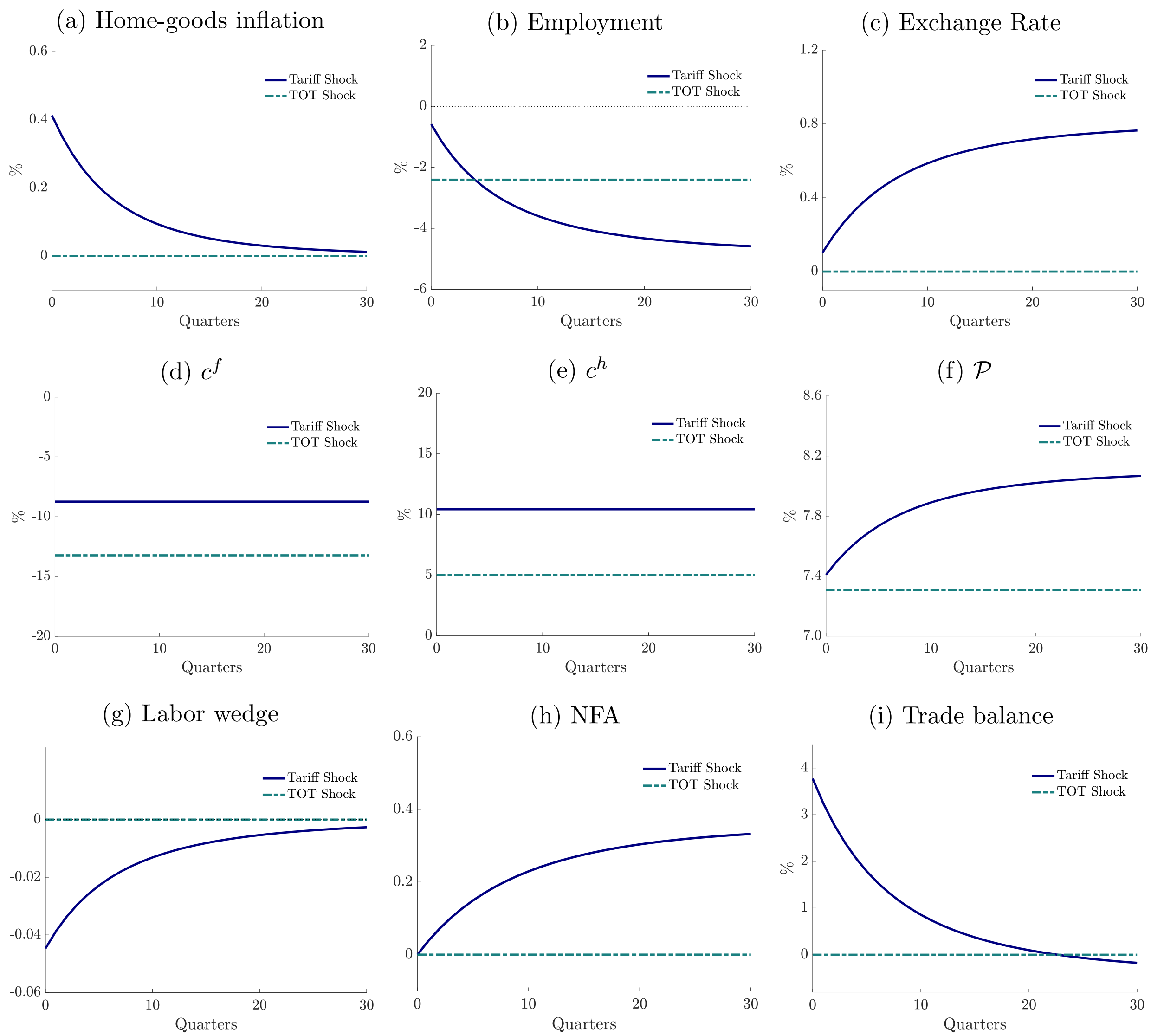
Figure D.5: Permanent tariff in the model with imported inputs



Notes: The tariffs are set to $\tau_t^c = 10\%$ and $\tau_t^x = 10\%$. The CPI targeting corresponds to the targeting rule (40) with coefficient $\phi_\pi = 1.5$. See the note on Figure D.1 for further details.

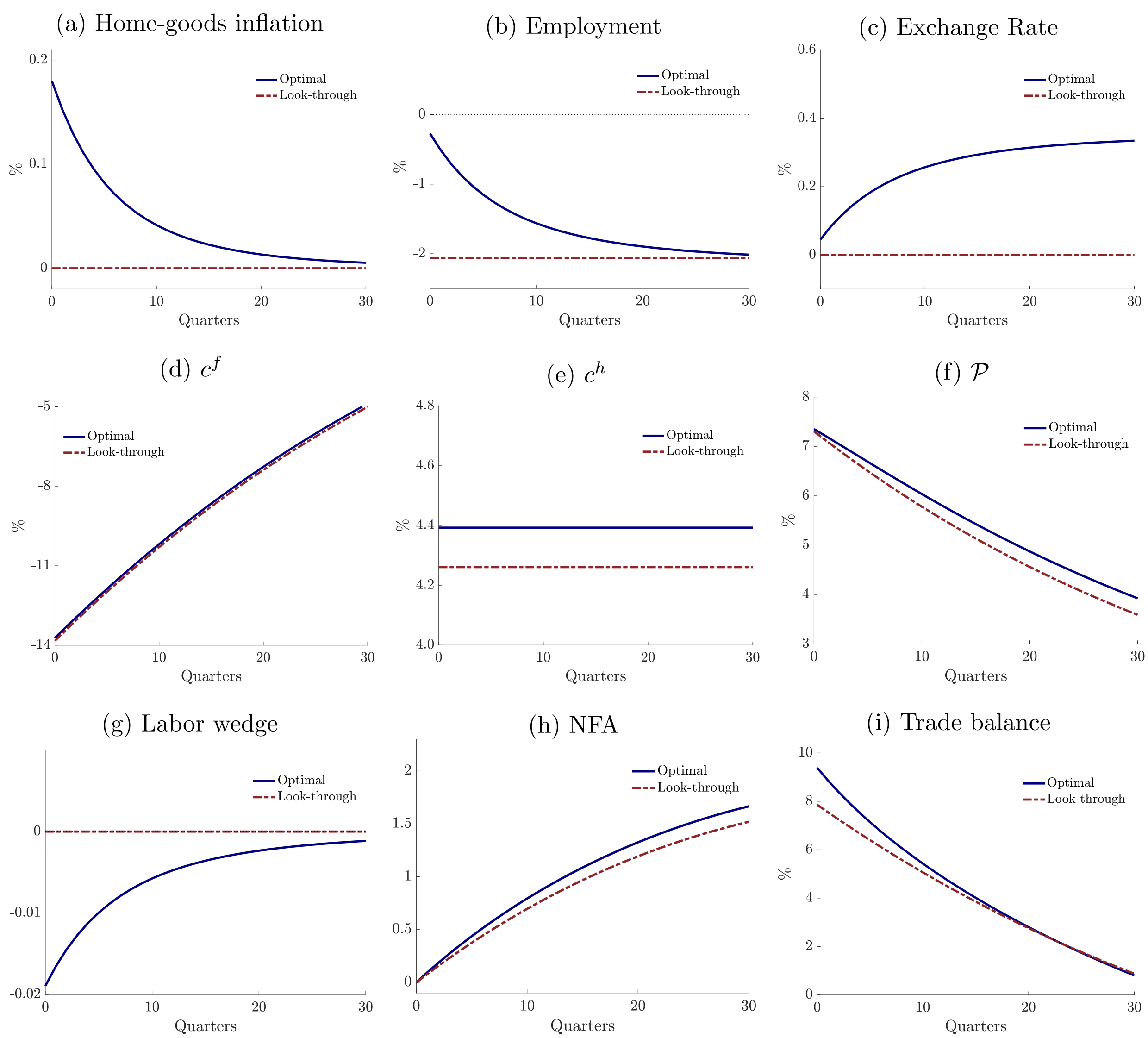
E Additional Figures

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



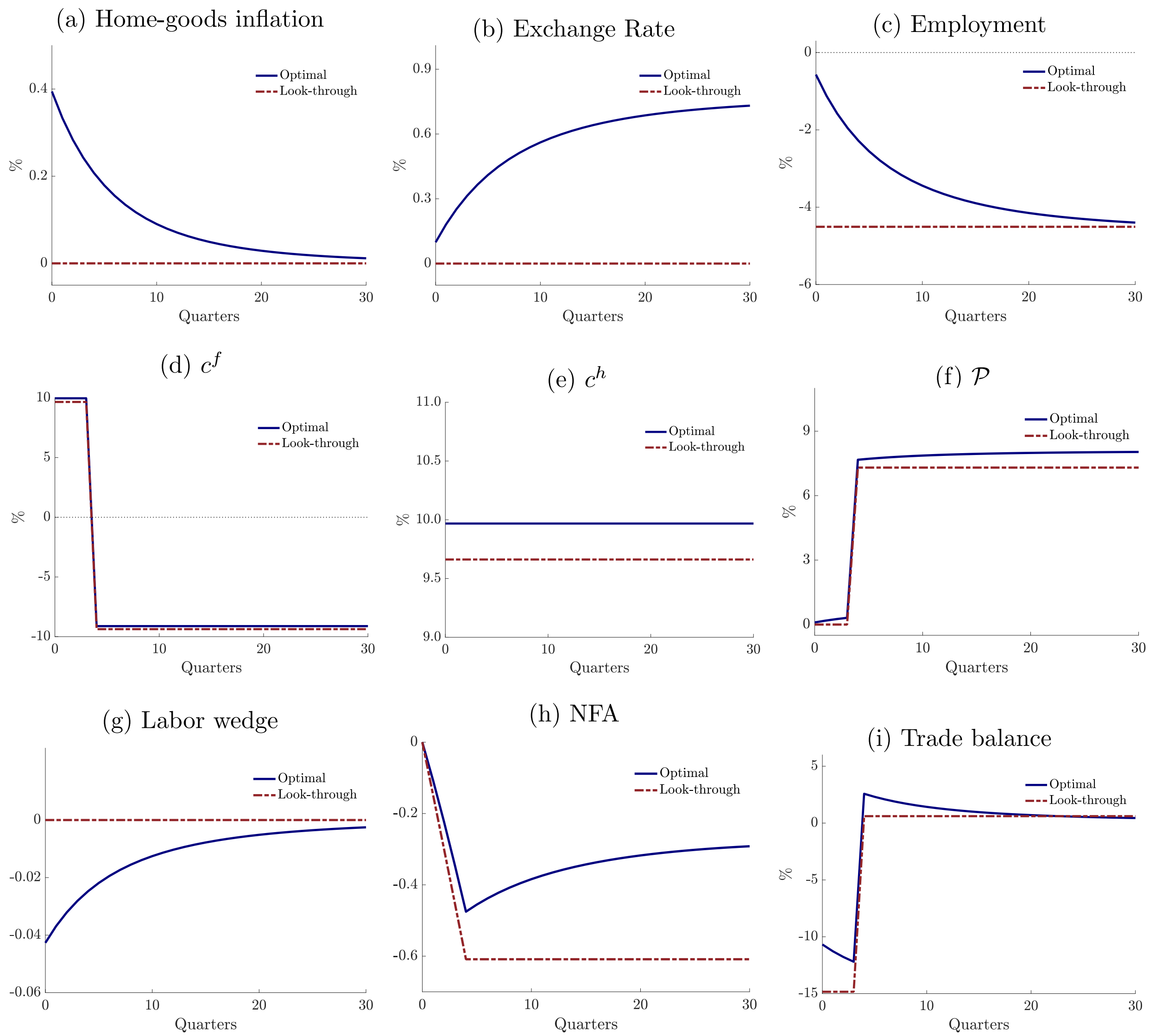
Notes: For the tariff shock, we set a constant tariff $\tau = 10\%$ and for the TOT shock, we assume a permanent 10% increase in p, driven by P^{f*}. In both cases, the simulations correspond to optimal monetary policy. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable price level are expressed in percentage deviation from the pre-tariff allocation.

Figure E.2: Temporary tariffs



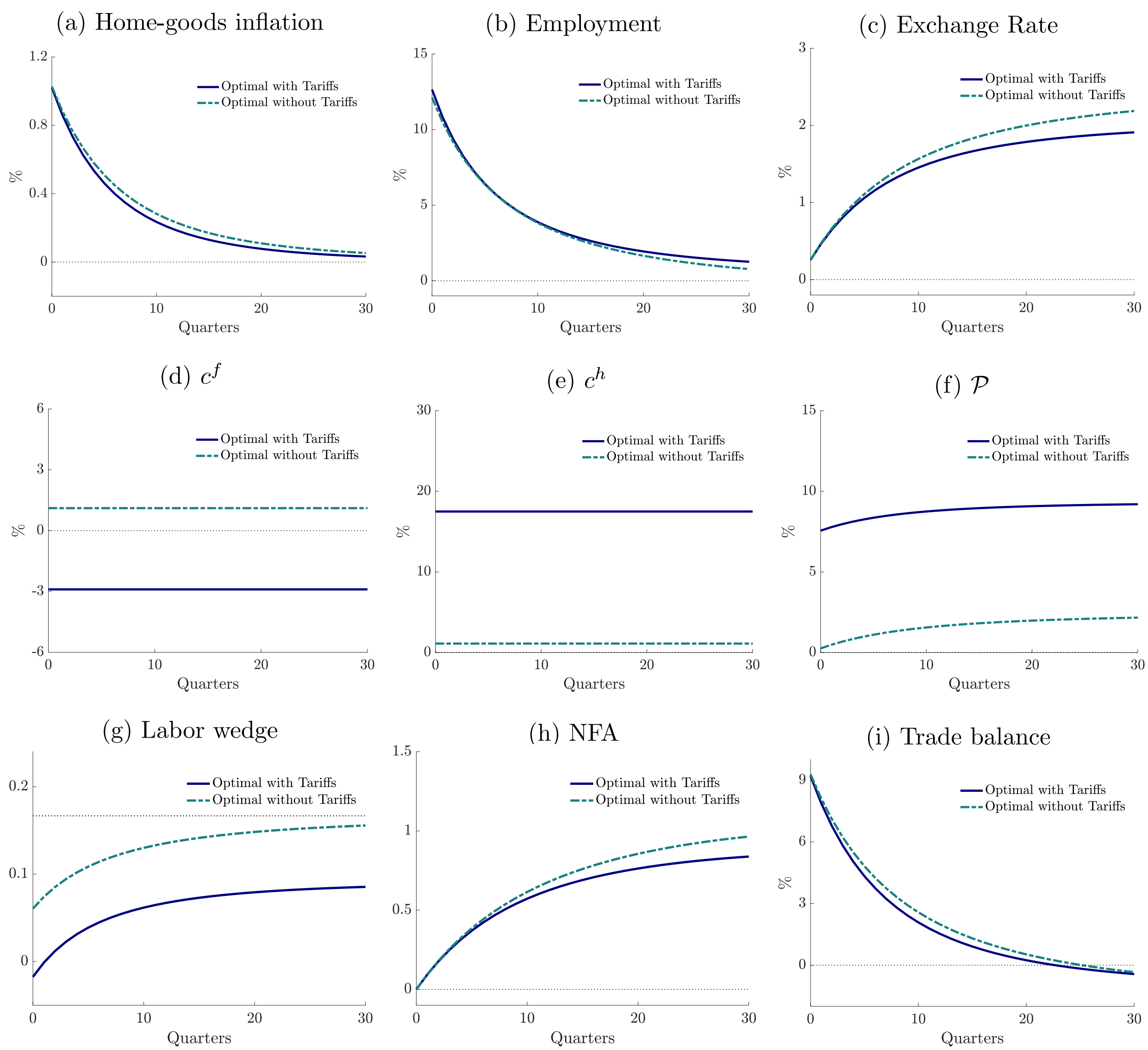
Notes: We assume that the tariff follows $\tau_t = \rho\tau_{t-1}$, 10% with $\tau_0 = 10\%$ and $\rho = 0.976$. Inflation is annualized. The trade balance and the NFA position are expressed as a fraction of GDP. Consumption, employment, the exchange rate, and the tradable price level are expressed in percentage deviation from the pre-tariff allocation.

Figure E.3: Anticipated tariffs



Notes: A permanent tariff of 10% 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 price level are expressed in percentage deviation from the pre-tariff allocation.

Figure E.4: Distorted steady state



Notes: The simulations assume that $s = 0$. The figure compares the optimal monetary policy absent tariffs to the optimal monetary policy response to a permanent tariff of $\tau = 10\%$ with $P_t^f \tau_t c_t^f = s_t W_t \ell_t$. Consumption of home goods, employment, the exchange rate and the price level are expressed as percent deviation from the pre-tariff steady-state allocation.