Optimal Monetary Policy Under Higher Tariffs*

Martin Bodenstein
Federal Reserve Board

Pablo Cuba-Borda
Federal Reserve Board

Albert Queralto
Federal Reserve Board

Ricardo Reyes-Heroles
Federal Reserve Bank of Dallas

Immo Schott
Federal Reserve Board

November 2025

PRELIMINARY

Abstract

We study the optimal monetary policy response to higher tariffs in a two-country New Keynesian model with trade in both final consumption goods and intermediate inputs, nominal price and wage rigidities, and input-output linkages. A key finding is that the inflation dynamics most relevant for monetary policy arise primarily when tariffs are levied on intermediate inputs rather than on final goods. Our analysis highlights four forces shaping the optimal response. First, when tariffs apply only to final goods, optimal monetary policy largely accommodates their effects. Second, when tariffs apply to intermediate inputs, they act as persistent cost-push shocks that raise real marginal costs, leading optimal policy to call for an increase in the nominal rate. Third, the strength—and even the sign—of the optimal interest rate response depends critically on the degree of nominal wage rigidity. Fourth, when tariffs are expected to be temporary, even with a modest probability of reversal, optimal monetary policy becomes significantly more restrictive, with both nominal and real rates rising.

JEL Codes: E1, E3, E5, F4, F6

*First version: December 2025. The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System. We thank seminar participants for useful comments.

1 Introduction

Shifts in U.S. trade policy since the beginning of 2025 have brought the macroeconomic impact of tariffs to the forefront of both policy and academic discussions—along with the question of the appropriate monetary policy response. A small but rapidly growing literature has begun exploring this question (Bianchi and Coulibaly, 2025; Werning, Lorenzoni, and Guerrieri, 2025; Monacelli, 2025).[1] However, a number of key issues remain open: *i)* do tariffs imposed on different types of goods warrant distinct monetary policy responses? Traditional macroeconomic models focus on tariffs affecting final consumption goods, leaving open the role of tariffs affecting intermediate input imports; *ii)* Does the presence of nominal wage rigidities significantly alter the optimal policy prescription? *iii)* What does optimal monetary policy imply for the prescribed response of the short-term nominal interest rate? The policy instrument is a key object of interest in practice. *iv)* What is the role of expectations of an eventual reversal of trade policy actions in shaping the optimal monetary policy response?

This paper contributes to the debate on the optimal monetary policy response to tariffs by developing a macroeconomic model of the global economy that incorporates both nominal wage and price rigidities, input-output linkages across countries (modeled through trade in intermediate inputs in addition to final consumption goods), and a Markov-switching structure for trade policy that captures expectations of a possible eventual reversal in tariffs. These elements add an important degree of realism to the related literature, which typically relies on a small open economy assumption, assumes trade in only one type of good (either final consumption or intermediate), and generally assumes that the tariff is permanent and understood as such by all agents. The presence of the new model features guides our attempt at answering the open questions posed above. In addition, by focusing on a realistically-calibrated model, our analysis complements the existing literature by providing a sense of magnitudes of the macroeconomic effects associated with shifts in tariff policy.

The analysis considers the imposition of a tariff by the home country (taken to be the United States) on imports from the rest of the world and then derives the optimal unilateral monetary policy response. The policymaker is assumed to operate under full commitment, and the problem is formulated from the timeless perspective (i.e., as a policy plan that has been in place for an indefinite period). To maintain comparability with the existing literature, the analysis focuses primarily on

[1] See Bergin and Corsetti (2023) for an earlier contribution and Auray, Devereux, and Eyquem (2025c,b) for related analyses.

cases in which the tariff is expected to remain permanent; the implications of anticipated reversal are examined in the final section.

Our analysis yields three main conclusions. First, optimal policy typically calls for an *increase* in the nominal interest rate. When the tariff is expected to be permanent, however, the nominal rate rises by less than one-for-one with expected inflation, implying a decline in the real rate. This moderates the economy's adjustment to the permanently lower employment level and permits positive domestic inflation during the transition, consistent with Werning et al. (2025). Crucially, the upward movement in the nominal rate under the optimal policy relies on the presence of tariffs on intermediate inputs together with nominal wage rigidity; in the absence of either feature, optimal policy instead prescribes a reduction in the nominal rate.

Second, the macroeconomic transmission of tariffs on final consumption goods differs sharply from that of tariffs on intermediate inputs. Under the optimal policy, a tariff on final consumption goods entails no meaningful response of the nominal interest rate and no notable inflation dynamics beyond a transitory spike in consumer price inflation occurring in the period the tariff is imposed. This case resembles the often-invoked "one-time" jump in the price level. In fact, domestic marginal costs actually fall somewhat in this case. This occurs due to a "spillover" effect operating through the terms of trade: By shifting demand toward domestically-produced goods, the tariff appreciates the home terms of trade, thereby lowering the cost domestic firms pay for imported inputs.

The picture differs sharply when tariffs are levied on intermediate inputs. Such tariffs distort production efficiency by pushing domestic producers toward imperfect substitutes, thereby inducing an inefficient allocation between intermediate input usage and labor. Combined with the presence of wage rigidity—which leads the planner to tolerate a small but persistent rise in wage inflation—domestic real marginal costs rise persistently, generating sustained domestic inflation. The nominal interest rate adjusts upward as a result.

These results emerge from analyzing tariffs on final goods and intermediate inputs separately. Under a uniform tariff on all imports, the macroeconomic effects lie between the two benchmark cases but align more closely with the intermediate-inputs case. This reflects a feature of our calibration, showing that trade openness in the U.S. economy is considerably larger for intermediate inputs than for final consumption goods.

Our third result is that the analysis changes substantially once the tariff is expected to be reversible with positive probability. In this case, optimal policy prescribes an *increase* in the real interest rate, coming from a sharper rise in the nominal rate than in the benchmark scenario

with no expected reversal. Notably, even a small probability of reversal (e.g., 2.5 percent per quarter) is sufficient to induce a rise in the real rate. Two mechanisms drive this result. First, the expectation of tariff reversal creates a motive for intertemporal substitution in consumption, generating a demand surge for domestic goods that the planner has an incentive to offset. Second, even a modest probability of reversal implies a much smaller appreciation of the home terms of trade, so the economy receives less "help" from the terms of trade to offset the direct inflationary effects of the tariff. Both channels call for a tighter monetary policy stance.

1.1 Related Literature

This paper is most closely related to the recent literature studying the interplay between trade and monetary policies. Motivated by the surge in protectionist policies since 2017, a number of studies rely on open-economy New Keynesian models to analyze the optimal monetary policy response to higher tariffs.

In an early contribution, Bergin and Corsetti (2023) compute the globally optimal monetary policy in response to tariffs in a two-country quantitative dynamic stochastic general equilibrium (DSGE) model. This paper focuses on exploring cooperative optimal monetary policy in response to either higher tariffs imposed on a given country's exports by its trading partner or a trade war in which the given country fully retaliates to the tariffs imposed on its exports. However, additional results in the paper show that the optimal policy stance in response to import tariffs should be contractionary. In terms of the nature of the exercise, our main deviation from Bergin and Corsetti (2023) is that we focus on the specific case of optimal unilateral monetary policy by the country imposing the tariffs. We believe this narrower focus provides a better understanding of the key mechanisms shaping the optimal monetary policy in response to a unilateral tariff increase under different assumptions about trade policy retaliation. In addition, we incorporate trade policy reversals and focus on how these, the relevance of imported intermediate inputs, and wage rigidities shape optimal monetary policy. Hence, we contribute by shedding light on the key determinants that shape the optimal monetary policy response to tariffs in a quantitative DSGE open-economy New-Keynesian model.

In recent work, Bianchi and Coulibaly (2025) consider a stylized model of a small open economy (SOE) with price rigidities to provide analytical results regarding optimal monetary policy response to higher tariffs. The paper shows that monetary policy in response to higher tariffs should be expansionary—in contrast to the result in Bergin and Corsetti (2023). Werning et al. (2025)

analyze the same question in an similar environment but focusing on tariffs on intermediate inputs rather than final goods and obtain similar results—higher tariff call for an expansionary monetary policy response. Monacelli (2025) also studies how monetary policy shapes the macroeconomic effects of tariffs in a SOE DSGE New Keynesian model. Similarly to other papers, the author concludes that in response to higher tariffs, optimal monetary policy is more expansionary relative to the one that implements the flexible price allocation. Our analysis contributes along multiple dimensions relative to these papers. First, we deviate from the SOE assumption while still focusing on unilateral trade policies. Second, we incorporate tariffs that differ across different types of goods and trade policy reversals, which are features that the literature on dynamic general equilibrium models of trade has shown to be key to understand the macroeconomic effects of trade policies (Cuba-Borda, Queralto, Reyes-Heroles, and Scaramucci, 2025b; Alessandria, Khan, Khederlarian, Ruhl, and Steinberg, 2025a,b). Third, we consider nominal wage rigidities, which are a key feature of quantitative DSGE New Keynesian models (Erceg, Henderson, and Levin, 2000; Christiano, Eichenbaum, and Evans, 2005), a framework that allows us to provide a sense of magnitudes in a realistically calibrated model of the global economy. Lastly, we highlight the response of the nominal policy rate—a key object in practice. Importantly, the features of our analysis allow us to better understand why the common result derived by these papers differs from that obtained by Bergin and Corsetti (2023).

Another strand of this literature extends these analyses by allowing for trade policy to be set optimally in a trade war. Auray et al. (2025c) study how the monetary policy shapes optimal trade policies. In a two-country open economy model with nominal rigidities in which trade policies arise as the Nash equilibrium of a game played by both countries, the authors show that the incentive to impose tariffs and the outcome of trade wars depend critically on the monetary policies being followed. Auray et al. (2025b) conduct a similar analysis but focusing on the case of interest rate monetary rules targeting inflation of CPI, PPI, or the exchange rate and find that, in contrast to the literature on optimal monetary policy in open economies (Corsetti, Dedola, and Leduc, 2010), targeting CPI rather than PPI dominate in terms of welfare outcomes. Relative to these papers, we focus on unilateral trade policies that are not chosen optimally. In addition, we incorporate wage rigidities and trade policy reversals into our model and emphasize their relevance in determining the optimal policy.

This paper is also closely related to the literature that focuses on the positive analysis of the effects of tariffs on the the macroeconomy through the lens of open-economy DSGE New Keynesian

models. Our model builds on Cuba-Borda et al. (2025b) who provide evidence on the effects of trade costs shocks—potentially driven by tariff shocks—on inflation and the macroeconomy and propose a model to study the mechanisms through which these shocks propagate to inflation. Barattieri, Cacciatore, and Ghironi (2021) study the short-run macroeconomic effects of protectionist policies in Canada. Auclert, Rognlie, and Straub (2025) and Auray, Devereux, and Eyquem (2025a) analyze the short-run macroeconomic effects of tariffs in small and large New Keynesian open-economy models, respectively.[2]

Roadmap The rest of paper is structured as follows. Section 2 sets up the model. Section 3 introduces the optimal monetary policy problem. Our quantitative experiments are shown in Section 5, before Section 6 concludes.

2 The Model

We develop a dynamic stochastic general equilibrium model to study the optimal monetary policy response to higher tariffs. Our model builds on the one proposed by Cuba-Borda et al. (2025b), who extend a multi-country New Keynesian model with nominal price and wage rigidities to also feature trade in final consumption goods and intermediate inputs to study how trade cost shocks affect inflation and macroeconomic outcomes.

Our model embeds a static Armington model of trade in final and intermediate goods into a dynamic framework. We assume that time is discrete and indexed by $t = 1, 2, \ldots$, and that the world is comprised of N countries indexed by $i, h \in \{1, \ldots, N\}$. We set up the model for any number of countries N and then focus on the case of two countries, $N = 2$, when we study optimal monetary policy. We assume that each of these countries has population ξ_i, for $i = 1, ..., N$, and we normalize world population to unity in every period. We assume country 1 (the home country) to be the United States.

Each country produces a unique tradable good that is available to all countries—that is, there is *national product differentiation*. There are three types of economic agents in each country: households, firms, and the government. Goods produced in any country can be bought either by households or firms in all countries around the world. Households buy goods for final use and firms buy them to use as intermediate inputs. In addition to trading final consumption goods and intermediate inputs, countries also trade in financial assets under incomplete international financial

[2]See also Erceg, Prestipino, and Raffo (2023); Ambrosino, Chan, and Tenreyro (2024)

markets. More precisely, countries can only trade a risk-free international bond denominated in (real) dollars, country 1's currency, across borders. Aside from the fact that country 1's currency is the one used in international financial markets, countries are otherwise symmetric. We proceed now to describe the structure of a generic country i.

2.1 Households

There is a continuum of households indexed by ℓ in each country. Within a country, households engage in monopolistic competition when supplying differentiated labor services to the production sector, as in Erceg et al. (2000). That is, goods-producing firms regard each household's labor as an imperfect substitute for the labor services of other households. Hence, the objective function of a household ℓ in country i is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U_i(C_{i,t}) - V_i(L_{i,t}^{\ell}) \right], \tag{1}$$

where $C_{i,t}$ is constant elasticity of substitution (CES) aggregator across source countries given by

$$C_{i,t} = \left(\sum_{h=1}^{N} \left(\omega_{ih}^{C}\right)^{\frac{1}{\eta^C}} \left(C_{ih,t}\right)^{\frac{\eta^C - 1}{\eta^C}} \right)^{\frac{\eta^C}{\eta^C - 1}}, \tag{2}$$

where $C_{ih,t}$ denotes the purchases by country i' consumers of goods produced in h at time t, $\eta^C > 0$ is the elasticity of substitution, and $\omega_{ih}^C > 0$ for $h = 1, \ldots, N$ are such that $\sum_{h=1}^{N} \omega_{ih}^C = 1$. For bilateral variables, we follow the convention of first writing the subscript for the importer (i in $C_{ih,t}$), followed by that of the exporter (h in $C_{ih,t}$). In (1), $L_{i,t}^{\ell}$ denotes labor services (hours) provided by household ℓ in country i.[3]

Trade of final consumption goods is subject to bilateral trade frictions given by $d_{ih,t}^C \geq 1$, denoting the friction faced by country i to import goods from country h in period t. In particular, we assume that these frictions are composed of two different types of costs. First, consumers in country i must pay exogenous add-valorem tariffs for goods imported from h, which we denote by $\tau_{ih,t}^C \geq 0$. Second, trade is subject to exogenous iceberg trade costs, denoted by $\kappa_{ih,t}^C \geq 1$, implying that for one unit of final consumption good produced in h to be delivered to i, $\kappa_{ih,t}^C$ units have to be shipped at time t, where we assume that $\kappa_{ii,t}^C = 1$. Therefore, total add-valorem trade frictions

[3] As is standard in this class of models, complete financial markets within country i ensure that all households ℓ consume the same amount, so we omit the ℓ index in $C_{i,t}$.

are given by $d^C_{ih,t} = (1 + \tau^C_{ih,t})\kappa^C_{ih,t}$, and $d^C_{ii,t} = 1$.

Let $P_{i,t}$ denote the price of the goods produced and sold in country i expressed in local currency units. If $\mathcal{E}_{ih,t}$ denotes the nominal bilateral exchange rate between countries i and h expressed in terms of country i's currency units per unit of country h's currency, then the price of a good produced and sold in country h in terms of country i's currency is defined by $P_{ih,t} \equiv \mathcal{E}_{ih,t}P_{h,t}$.

We assume that international goods markets are perfectly competitive, which implies that the Law of One Price (LOP) holds across countries. Hence, the price in local currency units that consumers in country i have to pay to acquire one unit of good produced in country h, $P^C_{ih,t}$, is given by $P^C_{ih,t} = d^C_{ih,t}P_{ih,t}$.

Household ℓ in country i seeks to maximize (1) subject to the budget constraint

$$\sum_{h=1}^{N} d^C_{ih,t}P_{ih,t}C_{ih,t} + B_{ii,t} + \frac{B_{i1,t}}{\mathcal{E}_{1i,t}} \leq W^\ell_{i,t}L^\ell_{i,t} + R_{i,t-1}B_{ii,t-1} + R_{1,t-1}\Psi_{i,t-1}\frac{B_{i1,t-1}}{\mathcal{E}_{1i,t}} + T_{i,t} \tag{3}$$

for all t, where $B_{ii,t}$ denotes holdings of domestically-traded bonds for country i, $B_{i1,t}$ denotes holdings of country 1's bond denominated in U.S. dollars, and $T_{i,t}$ are transfers to households in country i.[4] We allow risk premia to vary across countries through the term $\Psi_{1,t-1}$ in (3). These risk premium terms are such that $\Psi_{1,t} = 1$ and $\Psi_{i,t} \geq 1$ for $i \neq 1$. More specifically, we assume that for $i \neq 1$, $\Psi_{i,t}$ is given by

$$\Psi_{i,t} \equiv \left(1 - \psi\frac{b_{i1,t}}{\mathcal{Q}_{1i,t}Y_{i,t}}\right)\varepsilon^\psi_{i,t}, \tag{4}$$

where $b_{i1,t} \equiv \frac{B_{i1,t}}{P^C_{1,t}}$ denotes country i's borrowing in units of country 1's good, $Y_{i,t}$ denotes total tradable output in country i, $\varepsilon^\psi_{i,t}$ is an exogenous shock to the risk premium of country i, and $\mathcal{Q}_{ih,t}$ denotes the real exchange rate between country i and country h defined as

$$\mathcal{Q}_{ih,t} \equiv \frac{\mathcal{E}_{ih,t}P^C_{h,t}}{P^C_{i,t}}, \tag{5}$$

where $P^C_{i,t}$ is the ideal price index associated to consumers' aggregator (2). We explicitly state this price index in what follows.

Households in country i seek to minimize expenditure on final goods when choosing $\{C_{ih,t}\}_h$ conditional on $C_{i,t}$. The solution to this minimization problem delivers conditional demand

[4] Transfers to households include those from firms and the government. The specific transfers are provided in section 2.4.

functions for consumption goods given by

$$C_{ih,t} = \omega_{ih,t}^{C} \left(\frac{d_{ih,t}^{C} P_{ih,t}}{P_{i,t}^{C}} \right)^{-\eta^{C}} C_{i,t}, \tag{6}$$

where

$$P_{i,t}^{C} \equiv \left(\sum_{h=1}^{N} \omega_{ih,t}^{c} \left(d_{ih,t}^{C} P_{ih,t} \right)^{1-\eta^{C}} \right)^{\frac{1}{1-\eta^{C}}} \tag{7}$$

denotes the ideal price index for composite goods $C_{i,t}$.

Note that in (3), (6), and (7) we have expressed prices paid for final consumption goods i, $P_{ih,t}^{C}$, explicitly in terms of the trade costs for these goods, $d_{ih,t}^{C}$, and the bilateral prices that exclude these costs, $P_{ih,t}$. We do so to emphasize how changes in trade costs—tariffs in particular—directly affect the prices paid by final consumers and, therefore, directly impact their behavior—quantities purchased—and welfare.

Aggregate expenditure, $C_{i,t}$, is in turn determined by the household's intertemporal optimality condition for bonds denominated in domestic currency. The Euler equation characterizes this condition:

$$U_i'(C_{i,t}) = \beta R_{i,t} \mathbb{E}_t \left[\frac{U_i'(C_{i,t+1})}{\pi_{i,t+1}} \right], \tag{8}$$

where $\pi_{i,t} \equiv \frac{P_{i,t}^{C}}{P_{i,t-1}^{C}}$ denotes CPI inflation.

For countries that trade bonds denominated in a currency other than their domestic currency, that is, for countries other than country 1, a household's optimal portfolio choice is characterized by an uncovered interest parity (UIP) condition, which in real terms is given by

$$R_{i,t} \mathbb{E}_t \left[\frac{U_i'(C_{i,t+1})/U_i'(C_{i,t})}{\pi_{i,t+1}} \right] = R_{1,t} \Psi_{i,t} \mathbb{E}_t \left[\frac{U_i'(C_{i,t+1})/U_i'(C_{i,t})}{\pi_{1,t+1} \frac{\mathcal{Q}_{1i,t+1}}{\mathcal{Q}_{1i,t}}} \right]. \tag{9}$$

Hence, given our assumption about $\Psi_{i,t}$ in (4), we have that the uncovered interest rate parity condition between countries i and 1 will not hold if $\frac{b_{i1,t}}{\mathcal{Q}_{1i,t} Y_{i,t}}$ deviates from $\frac{1}{\psi}$.

2.1.1 Wage Setting

Following Erceg et al. (2000), we assume that there is an 'employment agency/union' in each country that combines households' labor services (hours) into an aggregate homogeneous labor input supplied to final producers, which we denote by $L_{i,t}$. The agency combines labor services across households according to

$$L_{i,t} = \left(\int_0^1 L_{i,t}^{\ell \, \frac{\epsilon_w - 1}{\epsilon_w}} d\ell \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}, \tag{10}$$

where $\epsilon_w > 1$. Given a profile of wages across household types, $\{W_{i,t}^{\ell}\}_{\ell}$, the agency seeks to minimize its hiring costs by demanding labor services of type ℓ household according to

$$L_{i,t}^{\ell} = \left(\frac{W_{i,t}^{\ell}}{W_{i,t}} \right)^{-\epsilon_w} L_{i,t}, \tag{11}$$

where

$$W_{i,t} = \left(\int_0^1 W_{i,t}^{\ell \, 1-\epsilon_w} d\ell \right)^{\frac{1}{1-\epsilon_w}}, \tag{12}$$

and $W_{i,t}$ can be interpreted as the aggregate wage index in country i.

Households' in each country compete in a monopolistic fashion in the labor market and therefore can set wages to maximize their utility. However, we assume that in any given period t, household ℓ can only reset its nominal wage, $W_{i,t}^{\ell}$, with probability $1 - \theta_w$, and that with probability θ_w, household ℓ's nominal wage has to be the same as in the previous period. Consider a household that can reset its nominal wage in period t. This household will choose its optimal reset nominal wage, $\overline{W}_{i,t}$, to maximize

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \theta_w^k \left(U_i(C_{i,t}) - V_i(L_{i,t+k|t}^{\ell}) \right), \tag{13}$$

where

$$L_{i,t+k|t}^{\ell} = \left(\frac{\overline{W}_{i,t}}{W_{i,t+k}} \right)^{-\epsilon_w} L_{i,t+k} \tag{14}$$

denotes labor demand in period $t + k$ for a wage setter that last reset its wage in period t.

The optimal reset nominal wage has to be such that the following first order condition holds:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \theta_w^k L_{i,t+k|t}^{\ell} U_i'(C_{i,t+k}) \left(\frac{\overline{W}_{i,t}}{P_{i,t+k}^C} - \frac{\epsilon_w}{\epsilon_w - 1} \frac{V_i'(L_{i,t+k|t}^{\ell})}{U_i'(C_{i,t+k})} \right) = 0. \tag{15}$$

Note that in the case in which workers can adjust wages in every period, $\theta_w^k = 0$, then we obtain the usual optimality condition that equates the real wage, $\overline{W}_{i,t}/P_{i,t}^C$, to the marginal rate of substitution, $V_i'(L_{i,t+k|t}^{\ell})/U_i'(C_{i,t+k})$, adjusted by the monopolistic distortion associated with a positive markup, $\epsilon_w/(\epsilon_w - 1)$. Since a measure θ_w of workers keep their wage unchanged and $1-\theta_w$ reset it optimally, the aggregate wage index, $W_{i,t}$, is such that $W_{i,t}^{1-\epsilon_w} = \theta_w (W_{i,t-1})^{1-\epsilon_w} + (1-\theta_w)(\overline{W}_{i,t})^{1-\epsilon_w}$.

The presence of wage dispersion associated with sticky wages induces in inefficient gap between the total (differentiated) labor supplied by households, $L_{i,t}^s \equiv \int_0^1 L_{i,t}^{\ell} d\ell$, and the (homogenous) labor supplied by the labor union for production, $L_{i,t}$:

$$\frac{1}{v_{i,t}^W} L_{i,t}^s = L_{i,t} \tag{16}$$

where wage dispersion is given by

$$v_{i,t}^W = \int_0^1 \left(\frac{W_{i,t}^{\ell}}{W_{i,t}} \right)^{-\epsilon_w} d\ell \geq 1 \tag{17}$$

2.2 Firms

There are two types of firms in each country. For the first type, a unit continuum of firms indexed by $v \in [0,1]$ produce differentiated goods that cannot be traded across borders. In country i, these goods are produced using the homogeneous labor supplied in country i and a bundle of intermediate inputs. The second class of firms consists of perfectly competitive identical retail firms that produce a final homogeneous good that can be traded internationally, subject to trade costs. These firms produce tradable goods by aggregating the differentiated goods produced by domestic firms. We first describe the technology and problem faced by the first type of firms and then proceed to describe these issues for the second type.

2.2.1 Differentiated Firms: Nontradables

Firm $v \in [0,1]$ in country i produces nontradable goods according to the production function

$$Y_{i,t}^v = A_{i,t}\left[(1-\nu)^{\frac{1}{\varepsilon_y}} L_{i,t}^{v\,\frac{\varepsilon_y-1}{\varepsilon_y}} + \nu^{\frac{1}{\varepsilon_y}} M_{i,t}^{v\,\frac{\varepsilon_y-1}{\varepsilon_y}}\right]^{\frac{\varepsilon_y}{\varepsilon_y-1}}, \tag{18}$$

where $A_{i,t}$ denotes exogenous productivity that does not vary across firms, $L_{i,t}^v$ is labor input, and $M_{i,t}^v$ is the amount of an intermediate input bundle used in production. The intermediate input, in turn, consists of an aggregate of goods produced in all countries according to the CES aggregator

$$M_{i,t} = \left(\sum_{h=1}^{N} \left(\omega_{ih}^M\right)^{\frac{1}{\eta^M}} \left(M_{ih,t}\right)^{\frac{\eta^M-1}{\eta^M}}\right)^{\frac{\eta^M}{\eta^M-1}}, \tag{19}$$

where $M_{ih,t}$ denotes the purchases by country i' firms of goods produced in h at time t, $\eta^M > 0$ is the elasticity of substitution, and $\omega_{ih}^M > 0$ for $h = 1, \ldots, N$ are such that $\sum_{h=1}^N \omega_{ih}^M = 1$. Note that, as long as $\eta^M < \infty$, intermediate inputs are not perfectly substitutable across countries. As for the case of the trade costs faced by households, we assume that the trade costs faced by firms, $d_{ih,t}^M$, are comprised of exogenous add-valorem tariffs, $\tau_{ih,t}^M$, and exogenous iceberg-type trade costs, $\kappa_{ih,t}^M \geq 1$, such that total trade costs are $d_{ih,t}^M = (1+\tau_{ih,t}^M)\kappa_{ih,t}^M$.

Given prices of country-specific tradable goods in global markets, $\{P_{i,t}\}_{i=1}^N$, retail firms in country i will seek to minimize the total cost of intermediate inputs, $\sum_{h=1}^N d_{ih,t}^M P_{ih,t} M_{ih,t}$, subject to (19) for a given level of $M_{i,t}$. The solution to the minimization problem yields demands for goods from different countries, $M_{ih,t}$, just as in the case of consumption goods, (6), with an ideal price index for the intermediate input bundle, $P_{i,t}^M$, as specified in (7) but with C switched for M.

Note that, even though households and firms import exactly the same good from any given country, they pay different prices to the extent that trade costs differ between final and intermediate goods.

Differentiated firms choose the amount of labor and the intermediate input bundle to minimize total production costs given by

$$W_{i,t} L_{i,t}^v + P_{i,t}^M M_{i,t}^v, \tag{20}$$

subject to (18). Given nominal wages and the price of the intermediate input bundle in country i, $P_{i,t}^M$, the solution to the cost minimization problem delivers the marginal cost faced by retail firms,

which is the same across firms and given by

$$MC_{i,t} = \frac{1}{A_{i,t}} \left[(1-\nu) {W_{i,t}}^{1-\varepsilon_y} + \nu (P^M_{i,t})^{1-\varepsilon_y} \right]^{\frac{1}{1-\varepsilon_y}}. \tag{21}$$

Note that changes in trade costs of intermediate inputs affect the nominal marginal cost of the firms directly through their effects on the price of the intermediate input bundle, $P^M_{i,t}$. Therefore, an increase in tariffs leading to a higher $P^M_{i,t}$ will increase firms' marginal costs and decrease production efficiency. Before analyzing the price setting behavior by firms producing differentiated goods, we describe the technology and problem of the representative retailer producing the homogeneous tradable good.

2.2.2 Retail Firms: Tradables

To produce tradable goods, the representative retail firm in country i aggregates differentiated goods available in i according to

$$Y_{i,t} = \left(\int_0^1 {Y^v_{i,t}}^{\frac{\epsilon-1}{\epsilon}} dv \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{22}$$

where $\epsilon > 0$. The output of the homogeneous good in country i can then be used for final consumption or as an intermediate input in the production of differentiated goods, either domestically or abroad.

Given the prices of different varieties, final good producers maximize profits subject to (22). The solution to this maximization problem delivers the demand for variety v in country i:

$$Y^v_{i,t} = \left(\frac{P^v_{i,t}}{P_{i,t}} \right)^{-\epsilon} Y_{i,t}, \tag{23}$$

where

$$P_{i,t} = \left[\int_0^1 (P^v_{i,t})^{1-\epsilon} dv \right]^{\frac{1}{1-\epsilon}} \tag{24}$$

defines the nominal price of a unit of the homogeneous good produced in country i in terms of its own currency, and $P^v_{i,t}$ denotes the nominal price charged by firm v in country i, also in terms of local currency units. As previously stated, excluding trade costs, the price of country i's imports from any country h is given by the price country h producers set domestically, adjusted for the

exchange rate between the two countries, $P_{ih,t} = \mathcal{E}_{ih,t} P_{h,t}$.

2.2.3 Price Setting by Differentiated Firms

Differentiated firms, in country i, set prices to sell their goods to retailers.[5] However, in line with our assumption of staggered wage adjustments, we assume that firm v can only reset its price in period t with probability $1-\theta$, and with probability θ it must keep its price unchanged relative to last quarter's.

Let $\overline{P}_{i,t}$ denote the optimal price for a firm that is able to reset its price in period t. Such a firm in country i will set this price to maximize

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \theta^k \frac{U'_{i,t}(C_{i,t})}{P^C_{i,t+k}} \left(\overline{P}_{i,t} - MC_{i,t+k}\right) \left(\frac{\overline{P}_{i,t}}{P_{i,t+k}}\right)^{-\epsilon} Y_{i,t+k}, \tag{25}$$

where the marginal cost is as specified in (21). The optimal price set by those firms able to adjust prices must be such that the following optimality condition holds:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \theta^k \frac{U'_{i,t}(C_{i,t})}{P^C_{i,t+j}} P^{\epsilon}_{i,t+k} Y_{i,t+k} \left[\overline{P}_{i,t} - \frac{\epsilon}{\epsilon - 1} MC_{i,t+k}\right] = 0. \tag{26}$$

Note that under flexible prices ($\theta = 0$), this condition reduces to the usual pricing condition, setting prices equal to a markup over marginal cost. Since a measure θ of firms keep their price unchanged and $1-\theta$ reset prices optimally, from (24) we obtain that $P_{i,t}$ satisfies the law of motion $P^{1-\epsilon}_{i,t} = \theta P^{1-\epsilon}_{i,t-1} + (1-\theta)\overline{P}^{1-\epsilon}_{i,t}$.

The presence of price dispersion associated with nominal rigidities induces an aggregate efficiency loss. Thus, the aggregate production function can be shown to satisfy

$$Y_{i,t} = \frac{A_{i,t}}{v^P_{i,t}} \left[(1-\nu)^{\frac{1}{\varepsilon_y}} L_{i,t}^{\frac{\varepsilon_y - 1}{\varepsilon_y}} + \nu^{\frac{1}{\varepsilon_y}} M_{i,t}^{\frac{\varepsilon_y - 1}{\varepsilon_y}}\right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}}, \tag{27}$$

with price dispersion given by

$$v^P_{1,t} \equiv \int_0^1 \left(\frac{P^v_{i,t}}{P_{i,t}}\right)^{-\epsilon} dv \geq 1. \tag{28}$$

[5] Note that in this model, firms engaging in international trade are perfectly competitive. Therefore, firms do not set prices in international markets. However, our assumptions are equivalent to allowing for price setting in international markets under producer currency pricing (PCP). That is, firms set prices in the currency of the country in which they produce and let their prices in the foreign currency adjust with the exchange rate.

In restating the aggregate production function we also made use of the fact that $L_{1,t} = \int_0^1 L_{i,t}^v dv$ and $M_{1,t} = \int_0^1 M_{i,t}^v dv$.

2.3 Government

We assume that the only taxes available to the government are tariffs. Furthermore, we assume that the government has no access to financial markets, thus it cannot borrow and it must run a balanced budget every period. Hence, the government simply transfers or rebates the revenue raised using tariffs directly to consumers in a lump-sum fashion. In this case, tariff revenues by country i in period t are given by

$$\mathcal{K}_{i,t} = \sum_{h=1}^{N} \left(\tau_{ih,t}^C \frac{d_{ih,t}^C P_{ih,t} C_{ih,t}}{1+\tau_{ih,t}^C} + \tau_{ih,t}^M \frac{d_{ih,t}^M P_{ih,t} M_{ih,t}}{1+\tau_{ih,t}^M} \right). \tag{29}$$

2.4 Market clearing and balance of payments

Tradable goods produced in country i are sold either domestically or abroad to country i's trading partners. Domestic or foreign buyers of these goods then consume them or use them as intermediate inputs. Hence, the market clearing conditions for these goods are given by

$$\xi_i Y_{i,t} = \sum_{h=1}^{N} \xi_h (\kappa_{hi,t}^C C_{hi,t} + \kappa_{hi,t}^M M_{hi,t}) \tag{30}$$

for $i = 1, ...N$, where the population terms ξ_i reflect the fact that all variables are expressed in per-capita terms. Note that (30) accounts for the goods that are lost when traded across countries because of the iceberg-type trade costs $\kappa_{hi,t}^Q \geq 1$ for $Q \in \{C, M\}$. In our baseline specification of the model we focus on tariffs and therefore will assume that iceberg-type trade costs are zero, $\kappa_{ih,t}^Q = 1$ for all i, h and for $Q \in \{C, M\}$.

We can derive the balance of payments condition for every country i, other than country 1 ($i \neq 1$), that determines the evolution of their holdings of dollar-denominated bonds. To do so, we aggregate domestic budget constraints and obtain

$$\sum_{h=1}^{N} d_{ih,t}^C P_{ih,t} C_{ih,t} + \frac{B_{i1,t}}{\mathcal{E}_{1i,t}} = W_{i,t} L_{i,t} + R_{1,t-1} \Psi_{i,t-1} \frac{B_{i1,t-1}}{\mathcal{E}_{1i,t}} + T_{i,t}, \tag{31}$$

where transfers to households in country i include tariff revenues that are rebated lump-sum to households and firms profits, $T_{i,t} = \mathcal{K}_{i,t} + \Pi_{i,t}$, where $\mathcal{K}_{i,t}$ is given by (29). Because profits are given

by $\Pi_{i,t} = P_{i,t}Y_{i,t} - W_{i,t}L_{i,t} - \sum_{h=1}^{N} \tau_{ih,t}^{M} P_{ih,t}M_{ih,t}$, (31) can be restated as

$$\sum_{h=1}^{N} \kappa_{ih,t}^{C} P_{ih,t}C_{ih,t} + \frac{B_{i1,t}}{\mathcal{E}_{1i,t}} = P_{i,t}Y_{i,t} - \sum_{h=1}^{N} \kappa_{ih,t}^{M} P_{ih,t}M_{ih,t} + R_{1,t-1}\Psi_{i,t-1}\frac{B_{i1,t-1}}{\mathcal{E}_{1i,t}}, \tag{32}$$

which does not depend on tariffs because we have imposed that all tariff revenues are rebated lump-sum to households. Hence, we obtain that the evolution of holdings of U.S. bonds for country i—prescribed by the balance-of-payments condition—is given by

$$B_{i1,t} - B_{i1,t-1} = \mathcal{E}_{1i,t}\left(EX_{i,t} - IM_{i,t}\right) + \left(R_{1,t-1}\Psi_{i,t-1} - 1\right)B_{i1,t-1}, \tag{33}$$

where $EX_{i,t} = P_{i,t}Y_{i,t} - P_{ii,t}C_{ii,t} - P_{ii,t}M_{ii,t}$ and $IM_{i,t} = \sum_{h\neq i} \kappa_{ih,t}^{C} P_{ih,t}C_{ih,t} + \sum_{h\neq i} \kappa_{ih,t}^{M} P_{ih,t}M_{ih,t}$ denote exports and imports. Condition (33) simply states that country i's current account is equal to its trade balance plus its net foreign investment income.

2.5 Monetary policy

To close the model we still need to specify monetary policy. We will focus on optimal monetary policy and describe in detail how we define and derive optimal monetary policy in the following section. However, we will also rely on Taylor-type monetary policy rules. Whenever we consider that the central bank in country i follows a Taylor rule, we assume that it sets the nominal interest rate according to an inertial policy rule given by

$$R_{i,t} = \left(R_{i,t-1}\right)^{\phi_i^r} \left(\frac{1}{\beta}\left(\pi_{i,t}\right)^{\phi_i^\pi} \left(\frac{GDP_{i,t}}{GDP_{i,t}^{flex}}\right)^{\phi_i^y} \varepsilon_{i,t}^{r}\right)^{1-\phi_i^r}, \tag{34}$$

where $GDP_{i,t}$ denotes real value added in country i, and $GDP_{i,t}^{flex}$ corresponds to the same object in the potential economy with flexible prices.[6] In (34), $\phi_i^r > 0$ determines the inertia in the monetary policy response, $\phi_i^\pi > 0$ and $\phi_i^y > 0$ parameterize the elasticities of the policy rate with respect to changes in inflation and GDP deviations from the central bank's zero inflation target and the natural level of GDP, respectively; $\varepsilon_{i,t}^r$ is an exogenous shock to the monetary policy rule.

[6] Real value added in country i (measured at steady-state relative prices) is given by $GDP_{i,t} = \frac{P_i}{P_i^C}Y_{i,t} - \frac{P_i^M}{P_i^C}M_{i,t}$, where no time subscript indicates steady state.

Table 1: Parameter Values

Parameter	Description	Value
β	Discount factor	0.99
σ	Inverse IES	0.5
η	Trade substitution elasticity consumption	3
η_m	Trade substitution elasticity intermediates	3
φ	Inverse labor supply elasticity	2
ϵ	Home varieties' substitution elasticity	6
ϵ_w	Labor varieties' substitution elasticity	6
$\Omega^C_{1,1}$	Home bias, consumption	0.94
$\Omega^M_{1,1}$	Home bias, intermediates	0.88
ξ^1	U.S. population size	0.2
θ, θ_w	Price, wage rigidity	0.85
ν	Intermediates weight in production	0.4
ε_y	Intermediates-labor substitution elasticity	0.5
ϕ_π	Taylor rule inflation coefficient	1.5
ϕ_y	Taylor rule output gap coefficient	0.0
ϕ_r	Taylor rule inertia	0.75
ψ	Risk premium elasticity to NFA	0

2.6 Calibration

We calibrate the model for two countries, $N = 2$, the U.S., $i = 1$, and the rest of the word, $i = 2$. Table 1 lists our parameter values, which are generally standard. See Cuba-Borda, Queralto, Reyes-Heroles, and Scaramucci (2025a) for details on the calibration.

3 The Optimal Policy Problem

We are interested in characterizing the unilateral optimal monetary policy of country 1 if country 1 imposes import tariffs. To do so, we follow a long line of research in assuming that, at time zero, the central bank commits to a fully state-contingent path of its policy instrument that maximizes the discounted life-time utility of the representative household (Woodford, 2003; Galí, 2015).

In determining the optimal path of policy policymakers are constrained by the first-order and equilibrium conditions of the model. While the Taylor-type rule of country 1 is dropped from this set of equations, monetary policy in country 2 continues to follow a Taylor-type rule. We summarize

these conditions in the system

$$\mathbb{E}_t\, g(x_{t-1}, x_t, x_{t+1}, \zeta_t) = 0. \tag{35}$$

Here x_t is a vector of all the endogenous variables in our model, inclusive of the policy instrument of country 1, whereas ζ_t is the vector of the exogenous disturbances. We follow Woodford (1999), in focusing on the optimal commitment policy from a timeless perspective. Under this assumption, policymakers pre-commit not to exercise discretion in period 0 – from a technical perspective this is achieved by adding the constraint $g\left(x_{-2}, x_{-1}, x_0, \zeta_0\right) = 0$.[7]

Altogether, the problem of the monetary authority in country 1 is given by

$$\begin{aligned} \max_{\{x_t\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U_i(x_{t-1}, x_t, \zeta_t) - V_i(x_{t-1}, x_t, \zeta_t)\right] \\ \text{s.t.} \quad \mathbb{E}_t\, g(x_{t-1}, x_t, x_{t+1}, \zeta_t) = 0, \\ g\left(x_{-2}, x_{-1}, x_0, \zeta_0\right) = 0. \end{aligned} \tag{36}$$

To derive the analytical conditions for an equilibrium associated with problem (36), we apply the symbolic differentiation toolbox of Bodenstein et al. (2019). The set of nonlinear first-order conditions associated with the policy problem can then be approximated around the deterministic steady state for further processing using local perturbation techniques. Alternatively, an extended path or Newton-like method can be used to find the equilibrium sequences of the endogenous variables associated with the set of nonlinear first-order conditions under perfect foresight.

3.1 Market Equilibrium

Setting the number of countries $N = 2$, we combine the first order optimality and equilibrium conditions displayed in Section 2 to obtain a more compact characterization of the model. To start, we define the relative price between the foreign and the domestic good in common currency as the

[7] In the presence of nominal rigidities, the central bank may be able to raise welfare at time zero through an unanticipated change in the stance of monetary policy given that prices and wages are largely predetermined. This situation can occur when the steady state of the model is inefficient or the economy experiences an inefficient shock. To eliminate the incentive to exercise time-zero discretion, we add a set of suitable restrictions at time zero (Benigno and Woodford, 2012; Bodenstein, Guerrieri, and LaBriola, 2019). The solution to this augmented problem yields time-invariant decision rules for the endogenous variables.

terms of trade. Under producer currency pricing, this implies

$$tot_{1,t} = \frac{\mathcal{E}_{11,t} P_{22,t}}{P_{11,t}}. \tag{37}$$

We also define the trade balance to export ratio as $\widetilde{Tb}_{1,t}$ with

$$\begin{aligned}
\widetilde{Tb}_{1,t} &= 1 - tot_{1,t} \frac{\xi_1}{\xi_2} \frac{\kappa^C_{12,t} C_{12,t} + \kappa^M_{12,t} M_{12,t}}{\kappa^C_{21,t} C_{21,t} + \kappa^M_{21,t} M_{21,t}} \\
&= 1 - \frac{\xi_1}{\xi_2} \frac{\omega^C_{12} \frac{\left(\kappa^C_{12,t} tot_{1,t} (1+\tau^C_{12,t})\right)^{1-\eta^C}}{\left(1+\tau^C_{12,t}\right)} \left(\frac{P^C_{1,t}}{P_{11,t}}\right)^{\eta^C} C_{1,t} + \omega^M_{12} \frac{\left(\kappa^M_{12,t} tot_{1,t} (1+\tau^M_{12,t})\right)^{1-\eta^M}}{\left(1+\tau^M_{12,t}\right)} \left(\frac{P^M_{1,t}}{P_{11,t}}\right)^{\eta^M} M_{1,t}}{\omega^C_{21} \left(\kappa^C_{21,t}\right)^{1-\eta^C} tot_{1,t}^{\eta^C} \left(\frac{P^C_{2,t}}{P_{22,t}}\right)^{\eta^C} C_{2,t} + \omega^M_{21} \left(\kappa^M_{21,t}\right)^{1-\eta^M} tot_{1,t}^{\eta^M} \left(\frac{P^M_{2,t}}{P_{22,t}}\right)^{\eta^M} M_{2,t}}.
\end{aligned} \tag{38}$$

The optimal choices of consumption goods and intermediate inputs, respectively, allow us to rewrite the market clearing condition (30) as

$$\begin{aligned}
Y_{1,t} &= \left\{ \omega^C_{11} \kappa^{C(1-\eta_c)}_{11,t} + \omega^C_{12} \frac{\left(\kappa^C_{12,t} tot_{1,t} (1+\tau^C_{12,t})\right)^{1-\eta^C}}{\left(1+\tau^C_{12,t}\right)\left(1-\widetilde{Tb}_{1,t}\right)} \right\} \left(\frac{P^C_{1,t}}{P_{11,t}}\right)^{\eta^C} C_{1,t} \\
&+ \left\{ \omega^M_{11} \kappa^{M(1-\eta^M)}_{11,t} + \omega^M_{12} \frac{\left(k^M_{12,t} tot_{1,t} \left(1+\tau^M_{12,t}\right)\right)^{1-\eta^M}}{\left(1+\tau^M_{12,t}\right)\left(1-\widetilde{Tb}_{1,t}\right)} \right\} \left(\frac{P^M_{1,t}}{P_{11,t}}\right)^{\eta^M} M_{1,t} \\
&= \Gamma^C_1 \left(\tau^C_{12,t}, tot_{1,t}, \widetilde{Tb}_{1,t}\right) C_{1,t} + \Gamma^M_1 \left(\tau^M_{12,t}, tot_{1,t}, \widetilde{Tb}_{1,t}\right) M_{1,t}
\end{aligned} \tag{39}$$

where the ideal price indices for consumption goods, $P^C_{1,t}$, and intermediate inputs, $P^M_{1,t}$, are

$$\frac{P^C_{1,t}}{P_{11,t}} = \left\{ \omega^C_{11} k^{C(1-\eta^C)}_{11} + \omega^C_{12} \left(k^C_{12} tot_{1,t} \left(1+\tau^C_{12,t}\right)\right)^{1-\eta^C} \right\}^{\frac{1}{1-\eta^C}}. \tag{40}$$

$$\frac{P^M_{1,t}}{P_{11,t}} = \left\{ \omega^M_{11} k^{M\,(1-\eta^M)}_{11} + \omega^M_{12} \left(k^M_{12} tot_{1,t} \left(1+\tau^M_{12,t}\right)\right)^{1-\eta^M} \right\}^{\frac{1}{1-\eta^M}}. \tag{41}$$

The aggregate production function (27) can be written as

$$Y_{1,t} = \frac{A_{1,t}}{v^P_{1,t} v^W_{1,t}} \left[1 + \frac{\nu}{1-\nu} \left(\frac{W_{1,t}}{P_{11,t}} \frac{P_{11,t}}{P^M_{1,t}} \right)^{\varepsilon_y - 1} \right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}} (1-\nu)^{\frac{1}{\varepsilon_y - 1}} L^s_{1,t}. \tag{42}$$

taking into account (16) and the optimal relative input choice of labor and intermediates

$$M_{1,t} = \frac{\nu}{1-\nu}\left(\frac{W_{1,t}}{P_{11,t}}\frac{P_{11,t}}{P^M_{1,t}}\right)^{\varepsilon_y}\frac{1}{v^W_{1,t}}L^s_{1,t}, \tag{43}$$

where (21) implies

$$\frac{W_{1,t}}{P_{11,t}}\frac{P_{11,t}}{P^M_{1,t}} = (1-\nu)^{\frac{1}{\varepsilon_y-1}}\left[\left(A_{1,t}\frac{MC_{1,t}}{P_{11,t}}\frac{P_{11,t}}{P^M_{1,t}}\right)^{1-\varepsilon_y} - \nu\right]^{\frac{1}{1-\varepsilon_y}}. \tag{44}$$

For the foreign country we obtain a set of equations analogous to (39)-(44).

Remark 1 *Equations (39)-(44) determine aggregate consumption in country 1 ($C_{1,t}$) as a function of the exogenous tariff rates $\left(\tau^C_{12,t}, \tau^M_{12,t}\right)$, the terms of trade ($tot_{1,t}$), the trade balance ($\widetilde{Tb}_{1,t}$)—through Γ^C, Γ^M, and $P^M_{1,t}/P_{11,t}$—the real marginal costs ($MC_{1,t}/P_{11,t}$), the dispersion of prices and wages ($v^P_{1,t}, v^W_{1,t}$), and household labor supply $\left(L^s_{1,t}\right)$:*

$$C_{1,t} = \left\{\frac{1}{\Gamma^C_{1,t}}\frac{A_{1,t}}{v^P_{1,t}v^W_{1,t}}\left[1+\frac{\nu}{1-\nu}\left(\frac{W_{1,t}}{P^M_{1,t}}\right)^{\varepsilon_y-1}\right]^{\frac{\varepsilon_y}{\varepsilon_y-1}}(1-\nu)^{\frac{1}{\varepsilon_y-1}} - \frac{1}{v^W_{1,t}}\frac{\Gamma^M_{1,t}}{\Gamma^C_{1,t}}\frac{\nu}{1-\nu}\left(\frac{W_{1,t}}{P^M_{1,t}}\right)^{\varepsilon_y}\right\}L^s_{1,t}. \tag{45}$$

The remaining conditions to determine the endogenous variables in equilibrium, $v^P_{1,t}$, $v^W_{1,t}$, $MC_{1,t}/P_{11,t}$, $b_{11,t}$, $tot_{1,t}$, $\widetilde{Tb}_{1,t}$, $R_{1,t}$, $L^s_{1,t}$ and their foreign counterparts are:

1. *the reset values of wages (15) and prices (26), and the evolution of price dispersion (16, 28);*
2. *the UIP condition (9), the evolution of the current account (33), and the definition of the trade balance (38);*
3. *the optimal asset demand condition (8), and the monetary policy rules (34).*

The equations listed here with the exception of the home country's monetary policy rule constitute the system of equilibrium conditions (35) that constrain the optimal policy stated in (36).

3.2 Constrained-Efficient Allocations

Before characterizing the optimal monetary policy, we consider the problem of a planner that maximizes welfare of households in country 1 by choosing allocations for country 1. The resulting allocations are constrained efficient because we assume that allocations and prices in the foreign economy are determined by market outcomes.[8]

The domestic planner faces xx constraints. The resource constraint states that total demand for country 1's good cannot exceed its production. Assuming that the international exchange of the domestic good for the foreign good occurs at the price $tot_{1,t}$, we obtain

$$\begin{aligned}&\left(\kappa_{11,t}^{C} C_{11,t}+\kappa_{11,t}^{M} M_{11,t}\right)+\left(\kappa_{12,t}^{C} C_{12,t}+\kappa_{12,t}^{M} M_{12,t}\right) tot_{1,t}+Tb_{1,t} \\ &=A_{1,t}\left[(1-\nu)^{\frac{1}{\varepsilon_y}} L_{1,t}^{\frac{\varepsilon_y-1}{\varepsilon_y}}+\nu^{\frac{1}{\varepsilon_y}}\left(\omega_{11}^{M \frac{1}{\eta^M}} M_{11,t}^{\frac{\eta^M-1}{\eta^M}}+\omega_{12}^{M \frac{1}{\eta^M}} M_{12,t}^{\frac{\eta^M-1}{\eta^M}}\right)^{\frac{\eta^M}{\eta^M-1}\frac{\varepsilon_y-1}{\varepsilon_y}}\right]^{\frac{\varepsilon_y}{\varepsilon_y-1}}.\end{aligned} \tag{46}$$

where the real, per-capita trade balance $Tb_{1,t}$ is defined as

$$Tb_{1,t}=\frac{\xi_2}{\xi_1}\left(\kappa_{21,t}^{C} C_{21,t}+\kappa_{21,t}^{M} M_{21,t}\right)-tot_{1,t}\left(\kappa_{12,t}^{C} C_{12,t}+\kappa_{12,t}^{M} M_{12,t}\right). \tag{47}$$

Under the constrained planning problem, the planner provides equal amounts of all varieties and demands equal amounts of each labor type. Nominal rigidities in price and wages are obsolete; thus $v_{1,t}^{P}=v_{1,t}^{W}=1$.

The real trade balance determines the evolution of real bond holdings $\tilde{b}_{21,t}$

$$\tilde{b}_{21,t}=TB_{1,t}+r_{1,t-1}\tilde{b}_{21,t-1}. \tag{48}$$

The real interest rate is denoted by $r_{1,t}$. Our assumption that the planner issues real debt/bonds departs from our original setting which assumes debt/bonds to be nominal. This assumption mirrors our assumptions regarding the planner's ability to overcome nominal price and wage rigidities.

The determine the constrained efficient allocations, the planner maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t\left[U_1\left(\left(\left(\omega_{11}^{C}\right)^{\frac{1}{\eta^C}}\left(C_{11,t}\right)^{\frac{\eta^C-1}{\eta^C}}+\left(\omega_{12}^{C}\right)^{\frac{1}{\eta^C}}\left(C_{12,t}\right)^{\frac{\eta^C-1}{\eta^C}}\right)^{\frac{\eta^C}{\eta^C-1}}\right)-V_1(L_{1,t})\right] \tag{49}$$

[8] Obtaining efficient allocations would require that the domestic planner could also set the allocations in the foreign economy directly.

subject to (46), (47), (48), and the equilibrium and market clearing conditions associated with the foreign country discussed in Remark 1.

3.2.1 Domestic Allocations

We focus on the domestic allocations $C_{11,t}$, $C_{12,t}$, $M_{11,t}$, $M_{12,t}$, $L_{1,t}$. The first order conditions associated with these variables reveal that the domestic planner establishes a wedge in the demand for foreign products which is equivalent to an import tariff. The wedge is identical for imports of the consumer good and the intermediate good.

The first-order conditions of the planner with respect to the domestic variables $C_{11,t}$, $C_{12,t}$, $M_{11,t}$, and $M_{12,t}$ imply

$$C_{11,t} = \left(\frac{\lambda_{1,t}}{U'_{1,t}}\right)^{-\eta^C} \omega_{11}^C \kappa_{11}^{C\,-\eta^c} C_{1,t} \tag{50}$$

$$C_{12,t} = \left(\frac{\lambda_{1,t}}{U'_{1,t}}\right)^{-\eta^C} \left(\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)^{-\eta^C} \omega_{12}^C \left(\kappa_{12}^C tot_{1,t}\right)^{-\eta^C} C_{1,t} \tag{51}$$

$$M_{11,t} = \left(A_{1,t}\left(\frac{\nu Y_{1,t}}{A_{1,t}M_{1,t}}\right)^{\frac{1}{\varepsilon_y}}\right)^{\eta^M} \omega_{11}^M \kappa_{11}^{M-\eta^M} M_{1,t} \tag{52}$$

$$M_{12,t} = \left(A_{1,t}\left(\frac{\nu Y_{1,t}}{A_{1,t}M_{1,t}}\right)^{\frac{1}{\varepsilon_y}}\right)^{\eta^M} \left(\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)^{-\eta^M} \left(k_{12}^M tot_{1,t}\right)^{-\eta^M} \omega_{12}^M M_{1,t} \tag{53}$$

where the aggregate consumption bundle $C_{1,t}$ is given by (2), and the aggregate intermediate input bundle $M_{1,t}$ is given by (19). The marginal utility of aggregate consumption is denoted by $U'_{1,t}(C_{1,t})$. $\lambda_{1,t}$ is the Lagrange multiplier on the resource constraint (46) and $\mu_{1,t}$ is the constraint on the definition of the trade balance (47).

Inserting the expressions for $C_{11,t}$ and $C_{12,t}$ into (2), yields

$$\frac{U'_{1,t}(C_{1,t})}{\lambda_{1,t}} = \left\{\omega_{11}^C k_{11}^{C\,1-\eta^C} + \omega_{12}^C \left(k_{12}^C tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)^{1-\eta^C}\right\}^{\frac{1}{1-\eta^C}}. \tag{54}$$

We proceed in a similar fashion with $M_{11,t}$ and $M_{12,t}$ and (19) to obtain

$$A_{1,t}\left(\frac{\nu Y_{1,t}}{A_{1,t}M_{1,t}}\right)^{\frac{1}{\varepsilon_y}} = \left\{\omega_{11}^M k_{11}^{M\,(1-\eta^M)} + \omega_{12}^M \left(k_{12}^M tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)^{1-\eta^M}\right\}^{\frac{1}{1-\eta^M}} \tag{55}$$

which, as shown below, equals the marginal product of the intermediate good, $MPM_{1,t}$.

Using this information, we can express the resource constraint (46) as

$$
\begin{aligned}
Y_{1,t} = & \left\{ \omega_{11}^{C} \kappa_{11,t}^{C1-\eta_c} + \omega_{12}^{C} \frac{\left(\kappa_{12,t}^{C} tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \right)^{1-\eta^C}}{\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \left(1 - \widetilde{Tb}_{1,t} \right)} \right\} \left(\frac{U'_{1,t}}{\lambda_{1,t}} \right)^{\eta^C} C_{1,t} \\
& + \left\{ \omega_{11}^{M} \kappa_{11,t}^{M1-\eta^M} + \omega_{12}^{M} \frac{\left(k_{12,t}^{M} tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \right)^{1-\eta^M}}{\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \left(1 - \widetilde{Tb}_{1,t} \right)} \right\} \left(MPM_{1,t} \right)^{\eta^M} M_{1,t} \\
& = \Gamma^C \left(\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}, tot_{1,t}, \widetilde{Tb}_{1,t} \right) C_{1,t} + \Gamma^M \left(\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}, tot_{1,t}, \widetilde{Tb}_{1,t} \right) M_{1,t}, \qquad (56)
\end{aligned}
$$

where the functions Γ^C and Γ^M are same as in (39). In line with the notation adopted in (56), we rewrite (47) as

$$
\begin{aligned}
\widetilde{Tb}_{1,t} = & \frac{Tb_{1,t}}{\frac{\xi_2}{\xi_1} \left(\kappa_{21,t}^{C} C_{21,t} + \kappa_{21,t}^{M} M_{21,t} \right)} = 1 - tot_{1,t} \frac{\xi_1}{\xi_2} \frac{\kappa_{12,t}^{C} C_{12,t} + \kappa_{12,t}^{M} M_{12,t}}{\kappa_{21,t}^{C} C_{21,t} + \kappa_{21,t}^{M} M_{21,t}} \\
= & 1 - \frac{\xi_1}{\xi_2} \frac{\omega_{12}^{C} \frac{\left(\kappa_{12,t}^{C} tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \right)^{1-\eta^C}}{\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}} \left(\frac{U'_{1,t}}{\lambda_{1,t}} \right)^{\eta^C} C_{1,t} + \omega_{12}^{M} \frac{\left(\kappa_{12,t}^{M} tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}} \right)^{1-\eta^M}}{\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}} \left(MPM_{1,t} \right)^{\eta^M} M_{1,t}}{\omega_{21}^{C} \left(\kappa_{21,t}^{C} \right)^{1-\eta^C} tot_{1,t}^{\eta^C} \left(\frac{P_{2,t}^{C}}{P_{22,t}} \right)^{\eta^C} C_{2,t} + \omega_{21}^{M} \left(\kappa_{21,t}^{M} \right)^{1-\eta^M} tot_{1,t}^{\eta^M} \left(\frac{P_{2,t}^{M}}{P_{22,t}} \right)^{\eta^M} M_{2,t}}. \qquad (57)
\end{aligned}
$$

The aggregate production function can be written as

$$
Y_{1,t} = A_{1,t} \left[1 + \frac{\nu}{1-\nu} \left(\frac{MPL_{1,t}}{MPM_{1,t}} \right)^{\varepsilon_y - 1} \right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}} (1-\nu)^{\frac{1}{\varepsilon_y - 1}} L_{1,t} \qquad (58)
$$

where the marginal products of labor, $MPL_{1,t}$, and intermediate inputs, $MPM_{1,t}$, satisfy

$$
MPL_{1,t} = A_{1,t} \left(\frac{(1-\nu) Y_{1,t}}{A_{1,t} L_{1,t}} \right)^{\frac{1}{\varepsilon_y}} \qquad (59)
$$

$$
MPM_{1,t} = A_{1,t} \left(\frac{\nu Y_{1,t}}{A_{1,t} M_{1,t}} \right)^{\frac{1}{\varepsilon_y}} \qquad (60)
$$

with

$$
\frac{MPL_{1,t}}{MPM_{1,t}} = (1-\nu)^{\frac{1}{\varepsilon_y - 1}} \left[\left(\frac{A_{1,t}}{MPM_{1,t}} \right)^{1-\varepsilon_y} - \nu \right]^{\frac{1}{1-\varepsilon_y}}. \qquad (61)
$$

Finally, the first-order condition with respect to $L_{1,t}$ delivers

$$V'_{1,t}\left(L_{1,t}\right) = \lambda_{1,t} MPL_{1,t}. \tag{62}$$

Combined with (61) and (54), it is

$$\frac{V'_{1,t}\left(L_{1,t}\right)}{U'_{1,t}\left(C_{1,t}\right)} = \frac{\left(1-\nu\right)^{\frac{1}{\varepsilon_y - 1}} \left[\left(\frac{A_{1,t}}{MPM_{1,t}}\right)^{1-\varepsilon_y} - \nu\right]^{\frac{1}{1-\varepsilon_y}} MPM_{1,t}}{\left\{\omega_{11}^C k_{11}^{C\,1-\eta^C} + \omega_{12}^C \left(k_{12}^C tot_{1,t} \frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)^{1-\eta^C}\right\}^{\frac{1}{1-\eta^C}}}. \tag{63}$$

Remark 2 *Equations (54)-(61) determine aggregate consumption in country 1 $(C_{1,t})$ as a function of the ratio of Lagrange multipliers $\left(\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}\right)$, the terms of trade $(tot_{1,t})$, the trade balance $(\widetilde{Tb}_{1,t})$—through Γ^C, Γ^M, $MPM_{1,t}$—and household labor supply $(L_{1,t})$:*

$$C_{1,t} = \left\{\frac{A_{1,t}}{\Gamma_{1,t}^C}\left[1 + \frac{\nu}{1-\nu}\left(\frac{MPL_{1,t}}{MPM_{1,t}}\right)^{\varepsilon_y - 1}\right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}} \left(1-\nu\right)^{\frac{1}{\varepsilon_y - 1}} - \frac{\Gamma_{1,t}^M}{\Gamma_{1,t}^C}\frac{\nu}{1-\nu}\left(\frac{MPL_{1,t}}{MPM_{1,t}}\right)^{\varepsilon_y}\right\} L_{1,t}. \tag{64}$$

Comparing equations () associated with the planning problem with equations () associated with the market equilibrium reveals that

1. *the relative price $\frac{P_{1,t}^C}{P_{11,t}}$ in the market economy corresponds to $\frac{U'_{1,t}(C_{1,t})}{\lambda_{1,t}}$ in the planning economy;*
2. *the relative price $\frac{P_{1,t}^M}{P_{11,t}}$ in the market economy corresponds to $MPM_{1,t}$ in the planning economy;*
3. *the real producer wage $\frac{W_{1,t}}{P_{11,t}}$ in the market economy corresponds to $MPL_{1,t}$ in the planning economy;*
4. *the equivalent of real marginal costs assumes the value of 1 in the planning economy.*

Comparing (74) with (64) we find that the planner implements a wedge, $\frac{\lambda_{1,t}+\mu_{1,t}}{\lambda_{1,t}}$, between the domestic and the imported goods. This wedge can be implemented as a tariff. The optimal tariff rates on imported goods are given by

$$\tau_{1,t}^C = \tau_{1,t}^M = \frac{\mu_{1,t}}{\lambda_{1,t}} \tag{65}$$

and are equal across uses of the imported goods. The tariff rates are time-varying and positive if $\mu_{1,t} > 0$.

3.2.2 Foreign Allocations and the Optimal Tariff

Allocations and prices in the foreign country are determined by a market outcomes and thus not directly chosen by the domestic planner. The relevant equations are as discussed in Section 3.1.

The dynamics of the Lagrange multipliers $\mu_{1,t}$ and $\lambda_{1,t}$ are importantly informed by the planner's first order condition with respect to $tot_{1,t}$:

$$\lambda_{1,t} + \mu_{1,t} = \frac{1}{\kappa^C_{12,t} C_{12,t} + \kappa^M_{12,t} M_{12,t}} \sum_{j \in J} \mathbb{E}_t \rho_{j,t} \left(\frac{\partial g_j}{\partial tot_{1,t}} \right) \tag{66}$$

where $\sum_{j \in J} \mathbb{E}_t \rho_{j,t} \left(\frac{\partial g_j}{\partial tot_{1,t}} \right)$ are the derivatives of the remaining J (foreign) equilibrium conditions with respect to $tot_{1,t}$ and $\rho_{j,t}$ is the Lagrange multiplier associated with condition j. The magnitude of the optimal tariff thus depends on the sensitivity of the economy to changes in the terms of trade. We show below for the case of simplifying assumptions, that the optimal tariff is inversely related to the export elasticity of the foreign country—the classic optimal tariff formula.

4 Optimal Monetary Policy and Tariffs in a Simplified Model

To make more progress we assume that

- trade is balanced, i.e. $Tb_{1,t} = \widetilde{Tb}_{1,t} = 0$,
- prices and wages are flexible in the foreign country,
- prices are sticky, but wages are flexible in the home country, i.e., $\frac{V'(L_{1,t})}{U'(C_{1,t})} = \frac{W_{11,t}}{P_{11,t}} \frac{P_{11,t}}{P^c_{11,t}}$,
- parameters are symmetric, i.e. $\omega^k_{11} = \omega^k_{22}$ for $k \in \{C, M\}$, $\eta^C = \eta^M$,
- trade costs are absent, i.e. $\kappa^k_{ij,t} = 1$ for $k \in \{C, M\}$, $i \in \{1, 2\}$ and $j \in \{1, 2\}$,
- the utility function satisfies $ln\left(C_{i,t}\right) - \frac{1}{1+\phi} L^{1+\phi}_{1,t}$.

Under these assumptions, the optimal monetary policy is derived from

$$C_{1,t} = \Upsilon\left(A_{1,t}, \tau^C_{12,t}, \tau^M_{12,t}, tot_{1,t}, \frac{MC_{1,t}}{P_{11,t}}, v^P_{1,t}\right) L_{1,t} \tag{67}$$

$$\frac{V'(L_{1,t})}{U'(C_{1,t})} = \Theta\left(A_{1,t}, \tau^C_{12,t}, \tau^M_{12,t}, tot_{1,t}, \frac{MC_{1,t}}{P_{11,t}}\right) \tag{68}$$

$$C_{2,t} = \Upsilon\left(A_{2,t}, 0, 0, \frac{1}{tot_{1,t}}, 1, 1\right) L_{1,t} \tag{69}$$

$$\frac{V'(L_{2,t})}{U'(C_{2,t})} = \Theta\left(A_{2,t}, 0, 0, \frac{1}{tot_{1,t}}, 1\right) \tag{70}$$

$$\Phi\left(A_{1,t}, 0, 0, \frac{1}{tot_{1,t}}, 1, 1, L_{2,t}\right) = tot_{1,t}\Phi\left(A_{1,t}, \tau^C_{12,t}, \tau^M_{12,t}, tot_{1,t}, \frac{MC_{1,t}}{P_{11,t}}, v^P_{1,t}, L_{1,t}\right) \tag{71}$$

4.1 Indirect Utility Function

To facilitate the subsequent discussion of optimal policy, we combine the model's optimality and equilibrium conditions to derive expressions that can help shed light on the economic intuition. We also use these equations to obtain an indirect utility function of the representative household in country 1.

we use a subset of the model's equilibrium and market clearing conditions to derive an indirect utility function in terms of the dispersion of prices $v^P_{1,t}$, the dispersion of wages $v^W_{1,t}$, relative prices, and household labor supply.

First, the market clearing condition for the domestically produced good, (30), can be written as

$$\begin{aligned} Y_{1,t} &= \underbrace{\Gamma_1\left(tot_{1,t}, T_{1,t}, \tau^C_{1,t}, \tau^M_{1,t}\right) C_{1,t}}_{\text{global use good 1 in consumption}} + \underbrace{\Omega_1\left(tot_{1,t}, T_{1,t}, \tau^C_{1,t}, \tau^M_{1,t}\right) M_{1,t}}_{\text{global use good 1 in production}} \\ &= \Gamma_{1,t} C_{1,t} + \Omega_{1,t} \frac{\nu}{1-\nu}\left(\frac{W_{1,t}}{P^M_{1,t}}\right)^{\varepsilon_y} \frac{1}{v^W_{1,t}} L_{1,t}, \end{aligned} \tag{72}$$

where the second line *i)* suppresses the dependence of Γ_1 and Ω_1 on the terms of trade, the trade balance, and the tariff structure, and *ii)* uses the first-order conditions of cost minimization to substitute out for the demand for intermediate inputs.

Second, optimal production of the domestically produced good following (18) satisfies

$$v^P_{1,t} Y_{1,t} = A_{1,t}\left[1 + \frac{\nu}{1-\nu}\left(\frac{W_{1,t}}{P^M_{1,t}}\right)^{\varepsilon_y - 1}\right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}} (1-\nu)^{\frac{1}{\varepsilon_y - 1}} \frac{1}{v^W_{1,t}} L_{1,t}. \tag{73}$$

Combining (72) and (73) allows us to express consumption as a function of labor, price and wage dispersion, and relative prices

$$C_{1,t} = \frac{1}{\Gamma_{1,t}} \left\{ \left[1 + \frac{\nu}{1-\nu} \left(\frac{W_{1,t}}{P^M_{1,t}} \right)^{\varepsilon_y - 1} \right]^{\frac{\varepsilon_y}{\varepsilon_y - 1}} (1-\nu)^{\frac{1}{\varepsilon_y - 1}} \frac{A_{1,t}}{v^P_{1,t}} - \Omega_{1,t} \frac{\nu}{1-\nu} \left(\frac{W_{1,t}}{P^M_{1,t}} \right)^{\varepsilon_y} \right\} \frac{1}{v^W_{1,t}} L_{1,t}. \tag{74}$$

According to (74), consumption is proportional to labor and decreases with higher dispersion of prices $v^P_{1,t}$ or wages $v^W_{1,t}$ as in a simple closed economy model with sticky prices and wages. The dispersion measure is bounded from below by 1. If the dispersion of prices exceeds one, the prices of differentiated goods are not equalized. Cheaper differentiated goods are used more heavily in the assembly of tradables which leads to efficiency losses given the concavity of the aggregator function shown in (22). Price dispersion is determined by current and past inflation. In a given period only some firms adjust prices optimally – with the magnitude of the change determining the inflation rate – implying that in general the (relative and nominal) prices of these firms will differ those of all another firms – changing price dispersion. The same logic applies to the relationship between wage dispersion and consumption, and wage inflation, respectively.

In an open economy with input-output linkages, $\nu > 0$, additional variables matter for consumption. The terms $\Gamma_{1,t}$ and $\Omega_{1,t}$ – both reflecting the role of the terms of trade, tariffs, and the trade balance – increase when the terms of trade deteriorate. Thus an appreciation of the term of trade raises consumption. In the presence of input-output linkages the ratio between wages and the price of intermediate inputs also matters with, all else equal, consumption being maximized when this ratio is around 1.

Using (74) to substitute out for consumption in the period-utility function yields our formulation of indirect utility. In a closed economy, we obtain the familiar expression

$$U_1 \left(C_{1,t} \right) - V_1 \left(L_{1,t} \right) = U_1 \left(\frac{1}{v^P_{1,t} v^W_{1,t}} L_{1,t} \right) - V_1 \left(L_{1,t} \right). \tag{75}$$

Let $\tilde{L}_{1,t}$ denote labor in a (possibly constrained) optimal economy without nominal rigidities. This reference economy may not necessarily coincide with the economy without nominal rigidities as shown in Benigno and Woodford (2005) when prices of price-setters and wages of wage-setters are distorted in the deterministic steady state. By construction, price and wage dispersion in the

reference economy are constant. Optimal monetary policy in the presence of nominal rigidities can than be understood as minimizing the distance between the outcomes in the economy with nominal rigidities and the reference economy over the (infinite) planning horizon.

Since we assume that the distortions associated with monopolistic competition in product and input markets are corrected by subsidies, the outcomes in the economy without nominal rigidities are a good approximation for the ideal reference economy. Thus, going forward, we compare the optimal monetary policy response in our model with sticky prices and wages, international and input-output linkages to the economy without nominal rigidities to provide intuition for the choices of the monetary authority.

5 Experiments

We study the optimal monetary policy response to unilateral tariff increases. To fix ideas, we begin by discussing the effects of tariffs in a flexible price economy without nominal frictions. The flexible price economy informs our general understanding of the near- and long-term effects of the tariffs in our model and serves as our reference economy against which we compare the optimal unilateral monetary policy when prices and wages are sticky. An important feature of our model is that it can distinguish between tariffs levied on final goods and intermediate goods. We show that this distinction has important implications for the optimal conduct of monetary policy.

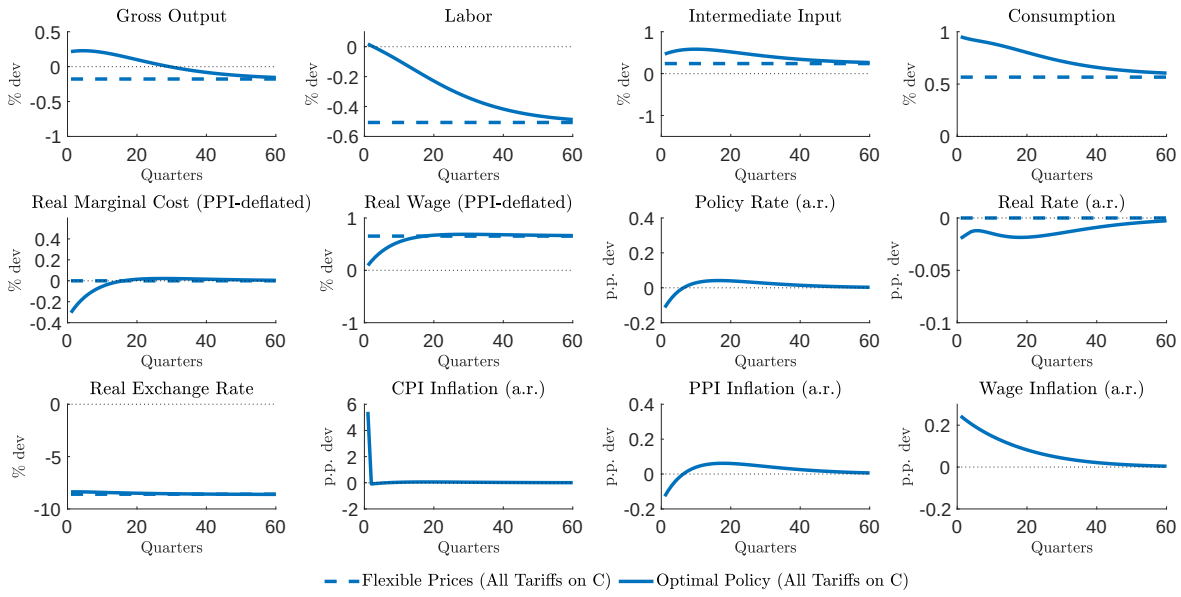
Across all experiments, the economy starts in a symmetric steady state with zero tariffs. The shock is an unanticipated ten percentage point permanent tariff increase. In Section 5.1, we study the effects of *i)* an increase in tariffs on final goods and *ii)* an increase in tariffs on intermediate goods – both separately and jointly – in the model without nominal rigidities and when monetary policy is set optimally in an economy with frictions. In 5.2 we highlight the effects of price and wage rigidities for our results. In 5.3 we show how the optimal monetary policy differs from the behavior of a standard Taylor rule. In 5.4 we discuss international spillovers. In 5.5 we discuss our results when agents place some probability on the possibility of a trade policy reversal.

5.1 Comparison: Flexible-Price vs. Optimal Monetary Policy

We start with a permanent increase in the tariff on imports of final goods, $\tau^C_{1,t}$, that is sized to raise tariff income of 10 percent on the overall value of imports. We then study an increase in the tariff on imports of intermediate goods, $\tau^M_{1,t}$, that is sized equivalently.

Tariff on Final Goods The blue dashed lines in Figure 1 show the response of the flexible price economy when tariffs are applied on final goods only. Tariffs on final goods shift domestic consumer demand away from imports toward the domestically produced good. This induces an improvement of the home country's terms of trade, proxied by the real exchange rate appreciation in Figure 1. In turn, this lowers the price of foreign intermediate goods and the price of intermediate goods overall. Absent nominal rigidities, real marginal costs remain unchanged. Thus, the decline in the price of imported intermediates caused by the terms-of-trade improvement must be offset by an increase in the producer real wage (nominal wage deflated by the domestic producer price). As a consequence, domestic producers substitute away from labor toward intermediate inputs. In addition, the fall in the foreign country's import demand exacerbates this shift away from domestic labor. Overall, these two channels more than offset the labor demand effects resulting from higher domestic demand for the domestic good.

Figure 1: Response to a 10 p.p. permanent tariff on final goods



Note: A permanent, 10 p.p. increase in tariffs on final goods occurs at time 0. The dashed lines show the response of the flexible price economy. The solid lines show the response of the economy with frictions when monetary policy is chosen optimally.

The presence of nominal rigidities changes the transmission of tariffs and creates a stabilization role for monetary policy. The blue solid lines in Figure 1 depict the optimal monetary policy response to the permanent increase in final good tariffs. In the long run, monetary policy cannot undo the effects of the tariff, so all variables converge to their flexible-price counterparts. In the short run, however, nominal rigidities prevent an instantaneous adjustment of relative prices

and quantities. The transition dynamics are therefore shaped by these rigidities together with the planner's assessment of how costly deviations from the flexible-price allocations are in welfare terms following our preliminary discussion in Section 3.

The transmission of tariffs on imported consumer goods under sticky prices and wages operates through several intertwined mechanisms, which apply not only under optimal monetary policy but more generally. A higher tariff $\tau^C_{1,t}$ affects domestic consumer prices through three channels: a direct mechanical effect on the price of imported consumption goods, an indirect effect through the terms-of-trade improvement (i.e., real exchange rate appreciation), and an effect operating through changes in production costs. These channels can be seen more clearly by examining the CPI inflation equation. The change in the CPI is approximately given by

$$\pi^{CPI}_{1,t} = \pi^{PPI}_{1,t} + \omega^C_{12}\left(\widehat{tot}_{1,t} + \tau^C_{1,t}\right) - \omega^C_{12}\left(\widehat{tot}_{1,t-1} + \tau^C_{1,t-1}\right) \tag{76}$$

where $\pi^{CPI}_{1,t}$ denotes quarterly CPI inflation, $\pi^{PPI}_{1,t}$ denotes quarterly PPI inflation, $\widehat{tot}_{1,t}$ denotes the change in the terms of trade, $\tau^C_{1,t}$ is the tariff on imported consumer goods, and ω^C_{12} is the weight on imports in the consumer basket.[9] Tariffs raise CPI inflation mechanically, while the terms-of-trade improvement ($\widehat{tot}_{1,t} < 0$) mitigates part of the inflationary pressure on impact. Beyond the impact period, the terms of trade barely move under a permanent tariff increase, so its contribution to CPI inflation are negligible. On impact, PPI inflation dampens the initial rise in CPI inflation because PPI inflation is negative. Later, as PPI inflation turns positive while the terms of trade and the tariff on consumption imports remain constant, movements in the PPI become the main driver of CPI inflation.

To understand PPI inflation, consider the evolution of real marginal costs, normalized by producer prices, which to a first-order approximation, follow:

$$\widehat{mc}^P_{1,t} = (1-\nu)\,\hat{w}^P_{1,t} + \nu\omega^M_{12}\left(\widehat{tot}_{1,t} + \tau^M_{1,t}\right) \tag{77}$$

where $\widehat{mc}^P_{1,t}$ denotes the change in real marginal costs, $\hat{w}^P_{1,t}$ denotes the change in real wages (both normalized by producer prices), $\tau^M_{1,t}$ denotes the tariff on imported intermediate inputs (equal to zero in this experiment), and ω^M_{12} the import share in the intermediate-input basket. The term $\omega^M_{12}\widehat{tot}_{1,t}$ captures the decline in production costs due to cheaper imported intermediates

[9] Variables carrying a "hat" are measured in log-deviations from the pre-tariff deterministic steady state. Inflation and tariff rates are measured in absolute deviations from their pre-tariff steady-state values.

following the terms-of-trade improvement. In the long run, real marginal costs return to zero as in the economy without nominal rigidities, which is consistent with PPI inflation converging back to its long-run target value. Because the permanent tariff raises the relative price of imported consumption goods and improves the terms of trade permanently, the producer real wage must increase in the long run to offset the cost-reducing effect of cheaper foreign intermediates.[10] In the near-term, however, sticky wages impede the adjustment of the producer real wage to its higher long-run level. Thus, on impact, the terms-of-trade improvement dominates and pushes marginal costs downward. Because, to a first order approximation, PPI inflation equals the infinite sum of marginal cost changes $\widehat{mc}^P_{1,t}$, the initial decline in marginal costs exerts deflationary pressure on domestic producer prices; indeed, PPI inflation is initially negative. Over time, rising producer real wages lift up real marginal costs and PPI inflation.

Finally, the evolution of the real producer wage and PPI inflation pins down wage inflation. In our setting, wage inflation $\pi^W_{1,t}$ evolves approximately according to

$$\pi^W_{1,t} = \hat{w}^P_{1,t} - \hat{w}^P_{1,t-1} + \pi^{PPI}_{1,t}. \tag{78}$$

Because the producer real wage must eventually rise in response to the tariff, wage setters increase their nominal wage when they can re-optimize, generating positive wage inflation. PPI inflation affects the speed of the real wage adjustment: negative PPI inflation helps raise real wages more quickly, while positive PPI inflation slows the process, thereby amplifying or dampening wage-inflation pressures in a given period.

With this transmission in mind, we turn to the considerations of the policymaker. Following our discussion in Section 3 and the expression for final household consumption in (74), the optimal policy aims to close the gaps between the outcomes in the actual economy with nominal rigidities to those in the economy without such frictions. The key gaps arise for labor, the real product wage, and dispersion of wages and prices.[11] While PPI inflation governs the dispersion of prices $v^P_{1,t}$ and wage inflation governs the dispersion of wages $v^W_{1,t}$, CPI inflation does not directly enter in (74) and thus welfare considerations. The real wage gap persists as nominal wages rise only slowly;

[10] In the flexible-price economy, the tariff on imported consumer goods causes the producer real wage to rise even though the marginal rate of substitution between consumption and leisure—equivalent to the consumer real wage—falls. The wedge is explained by the fact that the price of the final consumer basket rises more than the price of the domestically produced good.

[11] The terms of trade, the trade balance, and the real price of intermediate inputs (normalized by domestic producer prices) adjust very quickly towards their counterparts in the economy without nominal rigidities because nominal rigidities do not prevent their adjustment.

this slow adjustment of the real wage also slows down the decline in labor that has to occur in the longer-run.

Taken together, the monetary authority sees little need to adjust the nominal or the real interest rate in response to the tariff on consumption good imports. Although tighter financial conditions would slow wage inflation and wage dispersion, this would also delay the upward-adjustment of the real producer wage and decline in labor dictated by the tariff in the long run. In addition, PPI inflation would be more negative on impact and price dispersion would increase, lowering welfare further in this case.

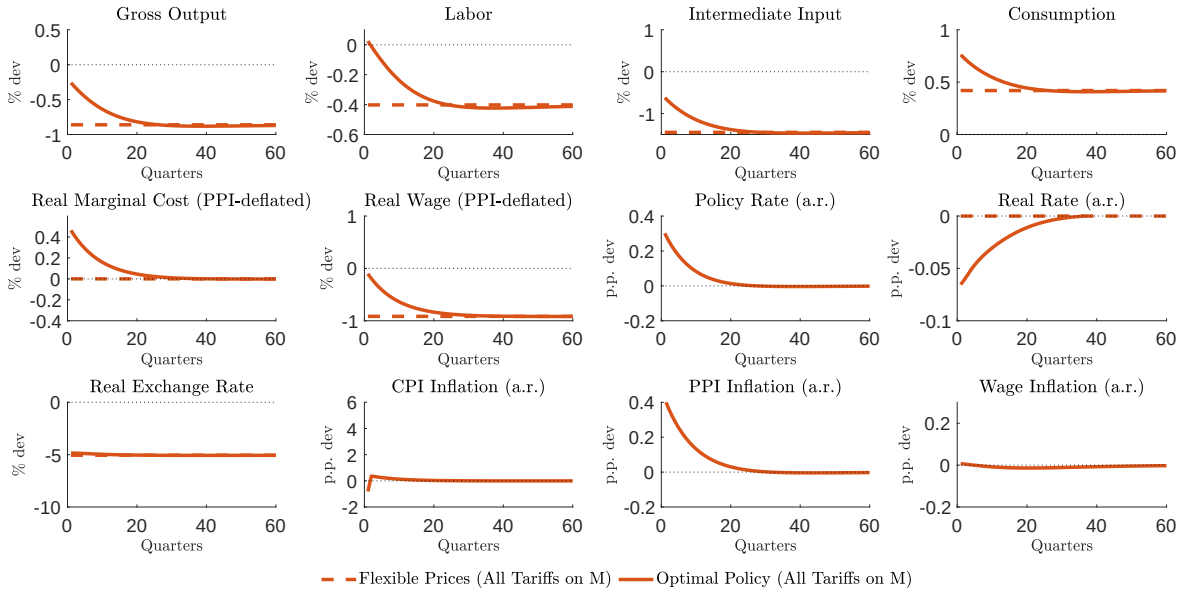
Tariff on Intermediate Goods Contrast this to the response of the economy following an increase in tariffs on *intermediate* goods shown in Figure 2. This tariff operates primarily through the supply side of the economy. Starting again with the outcomes in the flexible-price flexible wage economy, the permanent tariff increase, $\tau^M_{1,t} > 0$, raises the costs of imported intermediates relative to domestically produced ones. With demand for intermediate inputs shifting to domestic intermediate inputs, the home country's terms of trade improve, $\widehat{tot}_{1,t} < 0$. As can be seen in (77), the terms of trade appreciation partially offsets the upward pressure on domestic marginal costs from the tariff increase. Because real marginal costs are constant in the economy without nominal rigidities – the markup charged by monopolistic competitors is unaffected by the tariff – the remaining upward pressures on marginal costs are offset by a drop in the producer real wage, i.e. $\hat{w}^P_{1,t} = -\frac{\nu}{1-\nu}\omega^M_{12}\left(\widehat{tot}_{1,t} + \tau^M_{1,t}\right)$. As in the case of a tariff on consumer imports, the real appreciation allows domestic households to increase total consumption while lowering their labor effort.

In the economy with sticky prices and wages, the downward adjustment of the real wage is significantly delayed. Although the real exchange and, by extension, the terms of trade adjust quickly to their counterparts in the economy without nominal rigidities, the effects from the tariff are not fully offset so that real marginal costs rise on impact. The increase in marginal costs feeds into producer price inflation which in turn facilitates the decline in the real wage. In fact, under the optimal policy wage inflation barely moves, suggesting that price inflation is the main driver of the decline in the real wage.

While the use of intermediate inputs drops on impact, labor takes on a smoother path to its lower long-run level. While the use of labor remains elevated, consumption also exceeds its new long-run level.

Contrary to the case of $\tau^C_{1,t} > 0$, the nominal interest rate increases when $\tau^M_{1,t} > 0$ albeit by

Figure 2: Response to a 10 p.p. permanent tariff on intermediate goods



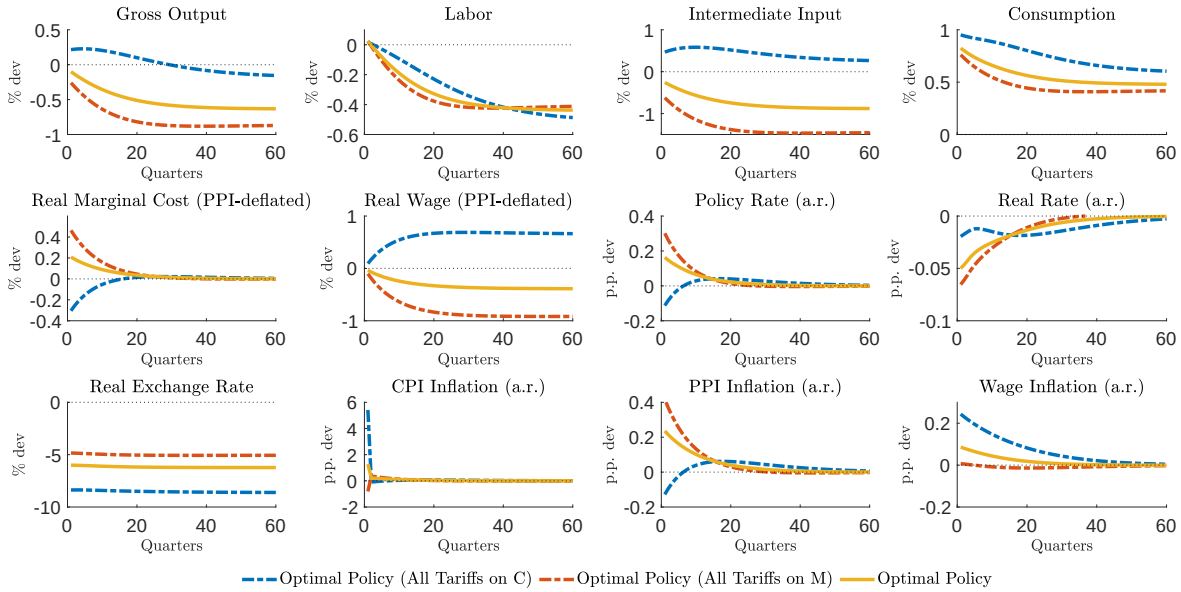
Note: A permanent, 10 p.p. increase in tariffs on intermediate goods occurs at time 0. The dashed lines show the response of the flexible price economy. The solid lines show the response of the economy with frictions when monetary policy is chosen optimally.

less than consumer prices, allowing the real interest to decline by a small amount. Following the discussion in Section 3, further nominal tightening would to be suboptimal: although activity would slow faster and the rise in PPI inflation would be smaller, the decline in the real wage would be slower and wage deflation would occur.

Tariffs on final and intermediate goods We summarize our results in Figure 3. The blue and red dashed lines show the response of the economy when tariffs are levied only on one type of good and monetary policy is chosen optimally, exactly as in Figures 1 and 2. The solid yellow line shows the results when tariffs are levied on both goods at the same time.

The figure highlights that the joint tariff case inherits its qualitative features primarily from the intermediate-input channel. While tariffs on final goods alone generate only limited inflationary pressure and a muted policy response, tariffs on intermediate inputs raise domestic marginal costs persistently through production distortions and their interaction with wage rigidities. As a result, the optimal monetary policy response under a uniform tariff closely tracks that of the intermediate-goods-only case. This reflects the empirically central role of imported intermediates in U.S. trade, which implies that the supply-side effects of tariffs dominate their demand-side counterparts when both types of goods are taxed simultaneously.

Figure 3: Response to a 10 p.p. permanent tariff on all goods



Note: A permanent, 10 p.p. increase in tariffs on final and intermediate goods occurs at time 0. The dashed lines show the response of the flexible price economy. The solid lines show the response of the economy with frictions when monetary policy is chosen optimally.

5.2 The Role of Nominal Wage Rigidity

What is the role of nominal wage rigidity in shaping the economy's response under optimal monetary policy? Figure 4 compares our baseline case with sticky prices and wages (blue solid lines) with a case with flexible wages but sticky prices (red dash-dotted lines).

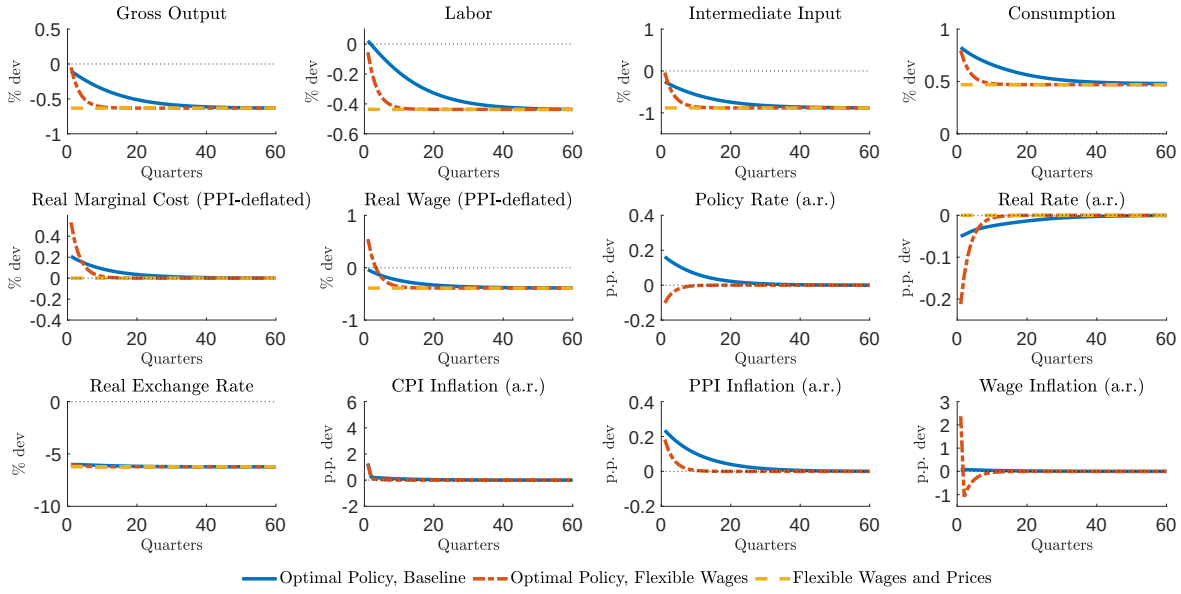
Under sticky prices but flexible wages, the planner initially allows for a sharper rise in real marginal cost, notably by permitting an initial boost to real wages. The real wage (PPI-deflated, that is, expressed in terms of domestic producer prices) jumps on impact in the simulation and then gradually falls to its new, lower, long-run level, which is depressed as a result of the production inefficiency associated with tariffs on intermediate inputs. By boosting the real wage, the planner is able to keep intermediate input usage high, partially offsetting the distortion created by the tariff on imported inputs. This result is in line with the arguments made in Werning et al. (2025).[12]

As seen in the last panel, the resulting real wage path is achieved through a large initial spike in nominal wage inflation, followed by a period of negative wage inflation. This volatility in nominal wage inflation is not costly under flexible wages, but it generates inefficient wage dispersion in our baseline model with nominal wage rigidities. Consequently, in the latter case the planner chooses

[12]This large initial boost to the producer real wage is especially evident in a version of Figure 4, not shown here, in which tariffs apply to intermediate inputs only.

a much more muted path for nominal wage inflation, with the real wage instead monotonically converging downward to its lower long-run level. Thus, with both sticky wages and sticky prices PPI inflation rises by more, and more persistently, than under flexible wages, as even modest expected wage inflation—rather than the wage deflation seen in the flexible-wage case—feeds into producer price inflation. Because of higher expected PPI inflation, the nominal policy rate now rises throughout the simulation, rather than falling as it does in the flexible-wage case, despite the decline in the real rate.

Figure 4: Role of sticky wages: Response to a 10 p.p. permanent increase in all tariffs



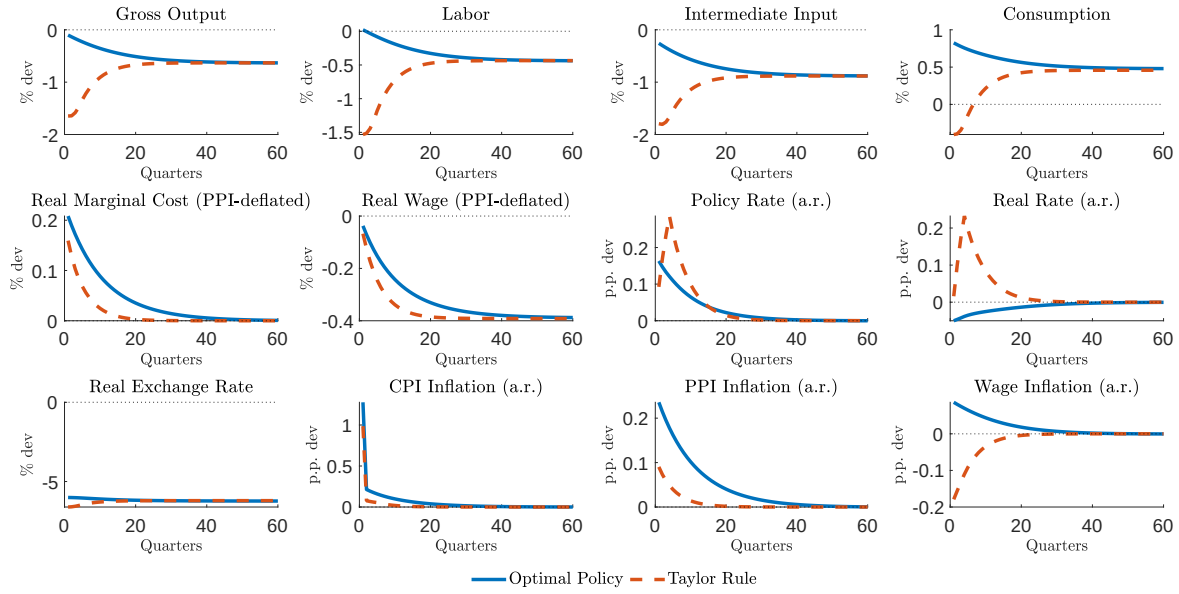
Note: A permanent, 10 p.p. increase in tariffs on final and intermediate goods occurs at time 0. The blue solid lines show our baseline results with wage and price rigidities. The red dash-dotted lines show the effects under flexible wages and sticky prices. The yellow dashed lines show the effects under flexible wages and prices.

5.3 Optimal Policy vs. a Taylor Rule

Finally, we compare the Ramsey allocation to a standard Taylor rule that responds only to CPI inflation (Figure 5). The Taylor rule prescribes a much stronger and more persistent increase in the policy rate than is optimal. Because CPI inflation rises after the tariff shock, the Taylor rule interprets the change as requiring a sustained monetary tightening, even though part of the inflation increase reflects an unavoidable deterioration in the terms of trade.

The excessive tightening under the Taylor rule amplifies the real contraction: labor, intermediates, and domestic output fall substantially more than under optimal policy. Inflation is stabilized more aggressively, but at the cost of larger welfare losses driven by a deeper real

Figure 5: Taylor Rule vs Optimal Policy: Response to a 10 p.p. permanent increase in all tariffs



Note: A permanent, 10 p.p. increase in tariffs on final and intermediate goods occurs at time 0. The blue solid lines show the results under optimal monetary policy. The red dashed lines show the results under a Taylor rule.

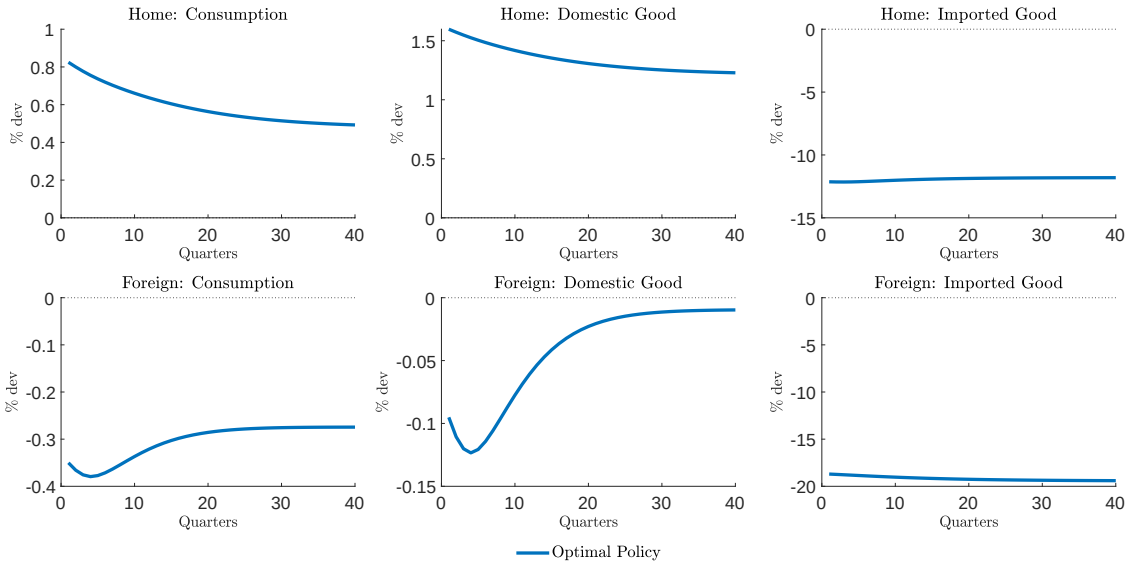
recession. The comparison underscores that a narrowly CPI-focused rule is too restrictive in the presence of real trade distortions.

5.4 International Spillovers

The optimal domestic policy generates adverse spillovers abroad (Figure 6). Home consumption rises—supported by the tariff-induced improvement in the terms of trade—while foreign consumption falls. Foreign demand for both home and imported goods contracts. These effects operate even though foreign policy remains unchanged: by limiting the domestic downturn and stabilizing domestic inflation, optimal home policy shifts expenditure toward home goods and away from foreign producers.

From the foreign perspective, optimal home stabilization is therefore beggar-thy-neighbor. A cooperative planner internalizing global welfare considerations would not choose the same response, emphasizing the tension between nationally optimal policy and global efficiency in a world with trade distortions.

Figure 6: Spillovers of Optimal Policy



Note: A permanent, 10 p.p. increase in tariffs on final and intermediate goods occurs at time 0. The blue solid lines show the results of the optimal unilateral monetary policy, both on the domestic economy (top row) and the rest of the world (bottom row).

5.5 The Role of Trade Reversal

In line with the emerging literature on the optimal monetary policy response to tariff increases, we assumed the trade policy changes to be permanent. However, in practice these changes might be far from permanent, and even if they turn out to be permanent (or at least in place for a very long time) economic agents may not expect them to be in place forever. It seems realistic to assume, for example, that agents might expect future trade deals to be reached, exemptions to be granted, or a given trade policy to be abandoned for other political or economic reasons. To account for the role of possible policy reversals, we turn to Markov-switching environment.

There is a growing literature on Markov-switching DSGE models (Farmer, Waggoner, and Zha, 2009; Bianchi and Melosi, 2017) using perturbation methods. Analysis of monetary policy in Markov-switching models tends to assume that policymakers follow a Taylor-type instrument role; optimal policy analysis is limited to settings in which the central bank adopts a simple loss function that is not necessarily derived from the utility function of the representative household (Zampolli, 2006; Svensson and Williams, 2008). We adopt an approach that allows us to implement the optimal monetary policy that is consistent with the preferences of the representative household in country 1. To do so, we employ the idea of targeting rules popularized by Svensson and Woodford (2004) and

Giannoni and Woodford (2017). An optimal targeting rule implements the optimal monetary policy derived from the policymaker's objective; this rule specifies the target variables, along with their relative importance and dynamic structure. Conceptually, the optimal targeting rule is obtained by recombining the first order conditions associated with the optimal monetary policy problem in (36). From this perspective, implementing optimal monetary policy in a Markov-switching environment follows the same steps as in the case of an instrument rule. To obtain the optimal targeting rule in our setting, we derive the analytical conditions for an equilibrium associated with the problem in (36) using the toolbox of Bodenstein et al. (2019). We approximate the full nonlinear system around its deterministic steady state using perturbation techniques and follow Farmer et al. (2009) to solve the Markov-switching model.

Let ξ_t denote a Markov-switching process. The set of tariffs on imports of final and intermediate goods are

$$\tau_t^i(\xi_t) = \{\tau_L^i, \tau_H^i\} \quad i = \{C, M\}. \tag{79}$$

For simplicity, we assume that there are only two states: in state 1 tariffs are low (L), in state 2 they are high (H). The transition matrix associated with this environment is give by:

$$P = \begin{bmatrix} \pi_{LL} & \pi_{LH} \\ \pi_{HL} & \pi_{HH} \end{bmatrix} = \begin{bmatrix} \Pr(\tau_{t+1}^i = \tau_L^i \mid \tau_t^i = \tau_L^i) & \Pr(\tau_{t+1}^i = \tau_H^i \mid \tau_t^i = \tau_L^i) \\ \Pr(\tau_{t+1}^i = \tau_L^i \mid \tau_t^i = \tau_H^i) & \Pr(\tau_{t+1}^i = \tau_H^i \mid \tau_t^i = \tau_H^i) \end{bmatrix}.$$

In the following, we set $\tau_L^i = 0\%, \tau_H^i = 10\%$, $\pi_{LL} = \pi_{HH} = 0.975$, and $\pi_{HL} = \pi_{LH} = 0.025$. Thus in both states, agents assign a probability of 2.5% of a regime switch. The equilibrium decision rules that we derive under these assumptions reflect these expectations.

To understand how the possibility of policy reversals affects the optimal monetary policy to tariffs we contrast two settings:

1. the Markov-switching environment described above, when the economy switches in period 1 from no tariffs to a 10% on both imports of intermediate and final goods and stays at the new tariff levels; however, agents do understand that the tariff increase may revers in the future;

2. the perfect foresight environment of the previous sections with 10% tariff being levied on both imports of intermediate and final goods; the tariff increase is believed to be permanent.

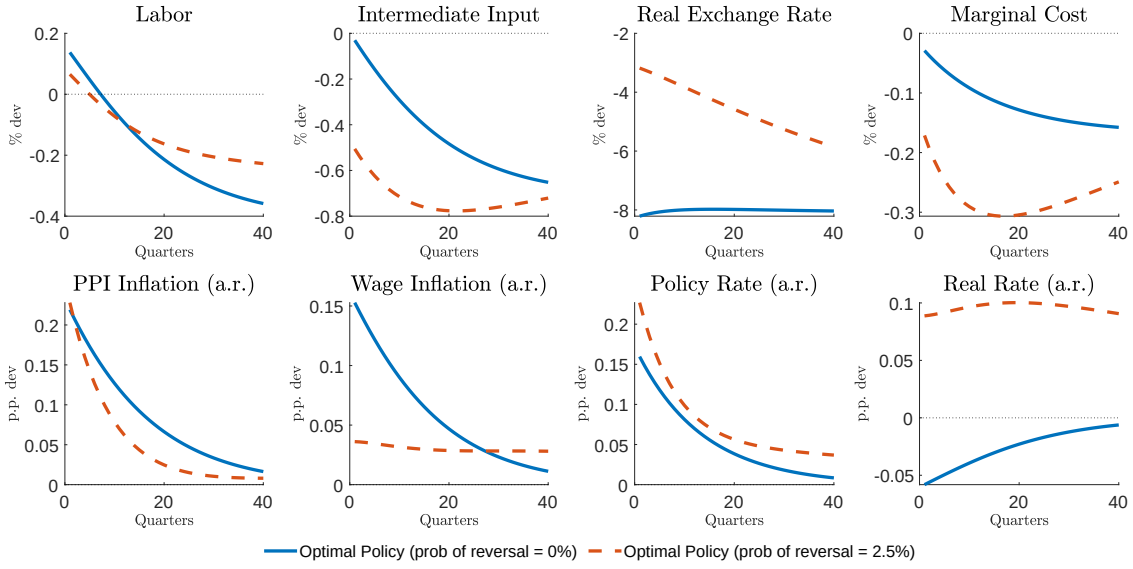
Figure 7 plots the impulse responses to the tariff increase.

When agents assign a positive probability to a trade policy reversal, the red dashed lines, the optimal monetary policy ends up raising both the nominal and the real interest rate in response to the tariff increase. By contrast, when agents believe the tariff increase to be permanent, the nominal interest rates rises by less and the real interest rate declines on impact.

The key driver of the differences between the two settings is the response of the real exchange rate (and the terms of trade). While the real exchange rate appreciates sharply on impact in the perfect foresight environment, the appreciation is much more gradual in the Markov-switching model. As a result, there is less offset from the terms of trade channel of the inflationary pressures that stem from the tariffs, see (77) and (76). Thus, overall inflationary pressures are stronger in the Markov-switching model precipitating a more forceful monetary policy response.

Note, that in the model with Markov-switching, the tariff shock is partially absorbed via the trade balance and the current account, leaving less need for the exchange rate to adjust. After all, the tariff is expected to go away at some point. When the tariff is expected to be permanent, the tariff shock cannot be smoothed via the trade balance and the current account and the external adjustment relies fully on the real exchange rate.

Figure 7: Risk of Tariff Reversal: Response to a 10 p.p. increase in all tariffs, no reversal



Note: A permanent, 10 p.p. increase in tariffs on final and intermediate goods occurs at time 0. The dashed lines show the response when agents assign a 2.5 percent probability to a trade policy reversal. The solid lines show the responses when the probability of reversal is 0.

Our findings are complemented by an additional experiment (not reported here) in which we assume that agents must learn the persistence of the tariff regime. The longer the high tariff regime

persists, the more likely agents believe the tariffs to remain high. In such a learning environment, the real exchange rate appreciates gradually over time and eventually reaches a similar level as in the perfect foresight experiment. In addition, each period the tariff increase remains in place changes household's beliefs about the tariffs' persistence which adds to inflation pressures. Inflation can become very persist.

More broadly, our results showcase the importance of the exchange rate/terms of trade channel for the inflationary pressures stemming from tariffs and the optimal monetary policy response. Whenever the terms of trade are prevented from offsetting the inflationary pressures from tariff increases – for example when the terms of trade do not improve sufficiently as under Markov switching, or the terms of trade improvement is not passed into the economy as under local currency pricing – monetary policymakers must be prepared to act more forcefully.

6 Conclusion

This paper studies the optimal unilateral monetary policy response to tariffs in a two-country New Keynesian model featuring both nominal price and wage rigidities, trade in final consumption goods and intermediate inputs, and a Markov-switching structure for trade policy. These ingredients allow us to revisit several open questions in the recent literature on tariffs and monetary policy within a quantitatively realistic global framework.

Our quantitative analysis delivers three main findings. First, when tariffs are expected to be permanent, optimal policy typically prescribes a rise in the nominal interest rate, but by less than expected inflation, so that the real rate falls and monetary policy partially accommodates the inflationary effects of tariffs. In contrast, once either tariffs on intermediate inputs or nominal wage rigidity are removed, the nominal rate falls under the optimal policy. Second, the transmission of tariffs depends crucially on their composition: tariffs on final goods mainly generate a one-off spike in consumer price inflation with little response of the policy rate, whereas tariffs on intermediate inputs act as persistent cost-push shocks that, in the presence of wage rigidity, raise real marginal costs and domestic inflation and call for a higher nominal interest rate. Third, when agents attach even a modest probability to future tariff reversal, optimal policy instead entails an increase in the real interest rate, as intertemporal substitution in consumption and a weaker terms-of-trade offset both strengthen the inflationary impact of tariffs and tilt the prescription toward monetary tightening relative to the permanent-tariff benchmark.

Taken together, our results highlight that the optimal monetary policy response to tariffs is highly sensitive to three features of the economic environment: the composition of trade between final and intermediate goods, the nature of nominal frictions—especially wage rigidity—and expectations about the persistence of trade policy. These findings help reconcile differing policy prescriptions in the existing literature and underscore that tariffs cannot be treated as a uniform shock from the perspective of monetary policy.

From a policy perspective, our analysis implies that assessing the inflationary consequences of tariffs requires careful attention to supply-chain exposure and to expectations about the durability of trade restrictions.

References

Alessandria, G., S. Y. Khan, A. Khederlarian, K. J. Ruhl, and J. B. Steinberg (2025a): "Trade Policy Dynamics: Evidence from 60 Years of US-China Trade," *Journal of Political Economy*, 133, 713–749.

——— (2025b): "Trade war and peace: US-China trade and tariff risk from 2015–2050," *Journal of International Economics*, 155, 104066.

Ambrosino, L., J. Chan, and S. Tenreyro (2024): "Trade fragmentation, inflationary pressures and monetary policy," Working Paper 1225, Bank for International Settlements, Monetary and Economic Department.

Auclert, A., M. Rognlie, and L. Straub (2025): "The Macroeconomics of Tariff Shocks," Working Paper 33726, National Bureau of Economic Research.

Auray, S., M. B. Devereux, and A. Eyquem (2025a): "Tariffs and Retaliation: A Brief Macroeconomic Analysis," Working Paper 33739, National Bureau of Economic Research.

——— (2025b): "Trade wars and the optimal design of monetary rules," *Journal of Monetary Economics*, 151, 103726.

——— (2025c): "Trade wars, nominal rigidities, and monetary policy," *Review of Economic Studies*, 92, 2228–2270.

Barattieri, A., M. Cacciatore, and F. Ghironi (2021): "Protectionism and the business cycle," *Journal of International Economics*, 129, 103417.

Benigno, P. and M. Woodford (2005): "Inflation Stabilization And Welfare: The Case Of A Distorted Steady State," *Journal of the European Economic Association*, 3, 1185–1236.

——— (2012): "Linear-quadratic approximation of optimal policy problems," *Journal of Economic Theory*, 147, 1–42.

Bergin, P. R. and G. Corsetti (2023): "The macroeconomic stabilization of tariff shocks: What is the optimal monetary response?" *Journal of International Economics*, 143.

Bianchi, F. and L. Melosi (2017): "Escaping the Great Recession," *American Economic Review*, 107, 1030–1058.

Bianchi, J. and L. Coulibaly (2025): "The Optimal Monetary Policy Response to Tariffs," Working Paper 33560, National Bureau of Economic Research.

Bodenstein, M., L. Guerrieri, and J. LaBriola (2019): "Macroeconomic policy games," *Journal of Monetary Economics*, 101, 64–81.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005): "Nominal rigidities and the dynamic effects of a shock to monetary policy," *Journal of political Economy*, 113, 1–45.

Corsetti, G., L. Dedola, and S. Leduc (2010): "Optimal Monetary Policy in Open Economies," in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3 of *Handbook of Monetary Economics*, 861–933.

Cuba-Borda, P., A. Queralto, R. Reyes-Heroles, and M. Scaramucci (2025a): "How Do Trade Disruptions Affect Inflation?" FEDS Notes, Board of Governors of the Federal Reserve System.

——— (2025b): "Trade Costs and Inflation Dynamics," Working paper, Federal Reserve Bank of Dallas.

Erceg, C., A. Prestipino, and A. Raffo (2023): "Trade Policies and Fiscal Devaluations," *American Economic Journal: Macroeconomics*, 15, 104–40.

Erceg, C. J., D. W. Henderson, and A. T. Levin (2000): "Optimal monetary policy with staggered wage and price contracts," *Journal of Monetary Economics*, 46, 281–313.

Farmer, R. E., D. F. Waggoner, and T. Zha (2009): "Understanding Markov-switching rational expectations models," *Journal of Economic Theory*, 144, 1849–1867.

Galí, J. (2015): *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications Second edition*, no. 10495 in Economics Books, Princeton University Press.

Giannoni, M. P. and M. Woodford (2017): "Optimal target criteria for stabilization policy," *Journal of Economic Theory*, 168, 55–106.

Monacelli, T. (2025): "Tariffs and Monetary Policy," Tech. rep., CEPR Discussion Paper.

Svensson, L. E. O. and N. Williams (2008): "Optimal monetary policy under uncertainty: a Markov jump-linear-quadratic approach," *Review*, 90, 275–294.

Svensson, L. E. O. and M. Woodford (2004): "Implementing Optimal Policy through Inflation-Forecast Targeting," .

Werning, I., G. Lorenzoni, and V. Guerrieri (2025): "Tariffs as Cost-Push Shocks: Implications for Optimal Monetary Policy," Working Paper 33772, National Bureau of Economic Research.

Woodford, M. (1999): "Commentary : How Should Monetary Policy be Conducted in an Era of Price Stability?" *Proceedings - Economic Policy Symposium - Jackson Hole*, None, 277–316.

——— (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press.

Zampolli, F. (2006): "Optimal monetary policy in a regime-switching economy: The response to abrupt shifts in exchange rate dynamics," *Journal of Economic Dynamics and Control*, 30, 1527–1567.