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Optimal Monetary Policy in the Tariff-Imposing Economy under Imperfect Pass-Through*

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Abstract

Should the central bank of a tariff-imposing economy raise or cut its nominal interest rate? In a small open economy, Ramsey policy raises the rate on impact under perfect pass-through (PPT) but cuts it under imperfect pass-through (IPT), and the impact cut carries over to a two-country economy. The law-of-one-price (LOOP) gap is the ratio of the Home-currency border acquisition price of imports to their *ex-tariff* import price. An import tariff induces inefficient underconsumption of imports and raises the welfare-relevant LOOP gap, giving the Ramsey planner an incentive to raise the actual LOOP gap. Through uncovered interest parity, monetary easing exerts depreciation pressure, which under IPT tends to raise the actual LOOP gap and thereby mitigates tariff-induced underconsumption, subject to competing inflation-stabilization objectives. Under reciprocal tariffs, by contrast, the optimal interest-rate cut is stronger under PPT than under IPT, because sticky import prices attenuate the expenditure switching induced by the partner country's monetary easing. The zero lower bound binds more readily under PPT than under IPT.

Keywords: Import tariffs; optimal monetary policy; law of one price; local-currency pricing; zero lower bound.

JEL Classification: E31, E52, F13, F41, F42.

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1 Introduction

Should a tariff-imposing country raise or cut its nominal interest rate? Monacelli [39] shows that CPI inflation targeting has a tightening bias relative to Ramsey policy, yet with perfect pass-through the Ramsey planner still raises the nominal rate, if only marginally. Under cooperative optimal policy, Bergin and Corsetti [10] find a rate increase even when exporters set prices in the destination-market currency. Bianchi and Coulibaly [13] characterize optimal policy as expansionary relative to strict producer-price stabilization; this comparison does not determine whether the nominal interest rate rises or falls.

We show that the answer depends on import-price pass-through. In a small open economy (SOE), under the conventional assumption of perfect pass-through (PPT), the Ramsey planner raises the nominal interest rate in response to an import tariff. In the imperfect pass-through (IPT) environment, in which local importers set sticky prices in Home currency, the planner instead cuts the rate on impact. Even in a two-country economy in which Foreign monetary policy responds endogenously, a rate cut on impact is optimal under IPT.

Following the local-currency-pricing (LCP) structure of Monacelli [38], we introduce monopolistically competitive local importers into the SOE model of Monacelli [39] and adopt its calibration. Home producers use producer-currency pricing (PCP). Local importers purchase goods at the border and set sticky *ex-tariff* import prices in Home currency, internalizing the effect of the tariff on their demand. The statutory tariff, levied on the border price, is added to the sticky *ex-tariff* price. Hence the tariff passes through to purchaser prices immediately, whereas the *ex-tariff* price adjusts only gradually to exchange-rate movements. Our PPT benchmark drops the importer block and is otherwise identical, so the comparison isolates the role of importer pricing. We then extend the model to a two-country economy in which the two national Ramsey planners play a noncooperative game, as in Faia and Monacelli [28].

Under IPT, the welfare cost of the tariff gives the Ramsey planner an incentive to ease. An increase in the Home import tariff raises the *cum-tariff* relative price of imports, inducing inefficient underconsumption of imported goods relative to Home goods. The Home law-of-one-price (LOOP) gap is the ratio of the Home-currency border price of imports to the *ex-tariff* import price charged by local importers in Home currency. For a given border price, a higher LOOP gap means a lower *ex-tariff* import price, which offsets part of the tariff-induced increase in the *cum-tariff* relative price of imports and mitigates the underconsumption. The tariff therefore raises the welfare-relevant LOOP gap, the value that the Home welfare cost function targets, and gives the planner an incentive to raise the actual LOOP gap toward it. We call this the Home Import-Allocation Channel (HIAC). For a given future nominal exchange rate and Foreign nominal interest rate, uncovered interest parity (UIP) implies that a lower Home nominal interest rate exerts depreciation pressure on the Home currency, raising the Home-currency border price of imports, which under IPT tends to raise the actual LOOP gap. The HIAC thus gives the Ramsey planner an incentive to cut the nominal interest rate in response to an import tariff, subject to the competing inflation-stabilization objectives. Because the tariff is highest on impact and then decays, so does the tariff-induced rise in the welfare-relevant LOOP gap; the planner therefore wants a weak Home currency on impact relative to later, which through UIP calls for a lower Home nominal interest rate on impact. Because monetary policy can move the LOOP gap only when *ex-tariff* import prices are sticky, the rate cut can also be traced to import-price stickiness. With sticky *ex-tariff* import prices, a higher LOOP gap is consistent with an increase in the Home PPI resulting from a rate cut, which puts upward pressure on the relative consumption of imports.

In the SOE, the contrast with PPT is especially transparent. Under PPT, import prices move one-for-one with the exchange rate, so the LOOP holds and the HIAC is absent. The tariff shifts expenditure toward Home goods and puts upward pressure on Home producer price index (PPI) inflation, and the planner raises the nominal interest rate. Under IPT, the tariff also shifts expenditure toward Home goods, but sticky local import prices attenuate the additional expenditure switching induced by exchange-rate movements, and the HIAC favors a rate cut.

The two-country economy adds a Foreign Allocation Channel (FAC). An increase in the Foreign

import tariff or a decline in the Foreign LOOP gap raises the *cum-tariff* relative price of Home goods faced by Foreign households, reducing their consumption of Home goods relative to Foreign goods. For a given Home output, this shifts the consumption of Home goods toward Home households, resulting in inefficient overconsumption of Home goods in Home. A higher Home LOOP gap lowers the *cum-tariff* relative price of imports faced by Home households and thereby mitigates this distortion, so the FAC also raises the Home welfare-relevant LOOP gap. A unilateral Home tariff lowers the Home rate on impact under IPT, even though the Home currency appreciates in equilibrium, whereas it raises the rate under PPT; the cumulative Home rate path under IPT remains below its PPT counterpart at every horizon. The IPT impact cut holds in every two-country unilateral experiment that we report, whereas the PPT rate increase does not.

Under reciprocal tariffs, both countries face a loss of export demand and optimally ease in either pass-through environment. Exchange-rate changes induce stronger expenditure switching under PPT than under IPT, where sticky local-currency import prices attenuate this mechanism. Foreign monetary easing therefore shifts Foreign expenditure away from Home goods more strongly under PPT, giving the Home planner a stronger incentive to support export demand. Accordingly, in contrast to the unilateral experiment, the optimal interest-rate cut is stronger under PPT than under IPT. The Home nominal interest rate therefore reaches the zero lower bound (ZLB) more readily under PPT than under IPT.

The rest of the paper is organized as follows. Section 2 relates our analysis to the literature on tariffs and monetary policy, exchange-rate pass-through, and international policy interaction and the ZLB. Section 3 presents the SOE model, the welfare cost function, and the optimal IPT response to a unilateral tariff, using PPT as a comparison. Section 4 extends the analysis to a two-country economy with noncooperative Ramsey policies and studies both unilateral and reciprocal tariffs, including ZLB episodes. Section 5 concludes. Appendix A provides the analytical benchmarks and sensitivity analysis of producer- and importer-price rigidity, and the Online Appendix provides the nonlinear equilibrium, Ramsey-policy, and welfare derivations and additional results.

2 Related Literature

2.1 Tariffs and Monetary Policy

The literature on tariffs and optimal monetary policy can be divided into two groups according to which country's monetary-policy response is studied.[1] The first group examines the economy on which a foreign country imposes tariffs. A foreign tariff reduces demand for that economy's exports, presenting its monetary authority with an adverse external-demand shock. Hamano, Pappadà, and Punzi [35], for example, study optimal monetary policy in the tariff-targeted economy, emphasizing exporter dynamics and labor reallocation. Monacelli [39] and Bergin and Corsetti [10] also analyze this side of a tariff shock and find that the optimal response of the tariff-targeted economy is expansionary.[2]

The second group, to which the present paper belongs, studies optimal monetary policy in the *tariff-imposing* economy. Important contributions include Monacelli [39], Bergin and Corsetti [10], Bianchi and Coulibaly [13], and Werning, Lorenzoni, and Guerrieri [43]. These studies either do not determine the sign of the nominal interest-rate response or find that the tariff-imposing country raises its nominal interest rate. In contrast, the Ramsey planner in the tariff-imposing economy cuts its nominal interest rate on impact in response to a unilateral tariff under IPT.

[1] Other related studies do not characterize the optimal monetary-policy response to a given tariff. Auray, Devereux, and Eyquem [5, 6, 8] study how monetary regimes, monetary delegation, and currency invoicing shape tariff wars and the effects of tariff shocks; Hwang and Turnovsky [36] analyze tariff effects under imperfect exchange-rate pass-through; and Amiti, Redding, and Weinstein [2] document the price and welfare effects of the 2018 U.S. tariffs. Auclert, Rognlie, and Straub [4] derive conditions under which temporary tariffs cause a recession, and Auray, Devereux, and Eyquem [7] quantify the macroeconomic effects of unilateral and retaliatory tariffs.

[2] Acharya, Challe, and Corsetti [1] study optimal monetary policy after export shocks, including those caused by foreign tariffs, in a small open economy with heterogeneous households. They show that the optimal policy requires more exchange-rate flexibility than flexible inflation targeting provides.

Monacelli [39] shows that the effects of import tariffs in a small-open-economy New Keynesian framework depend on the monetary-policy regime. His environment is our PPT benchmark, against which we compare IPT.

Bianchi and Coulibaly [13] study an economy with a production subsidy that corrects the steady-state monopoly distortion and emphasize that strict stabilization of domestic PPI inflation is not optimal following an import-tariff increase. Unlike their model, ours does not subsidize domestic producers. Because a fixed importer subsidy removes the steady-state importer markup under IPT, PPT and IPT share the same zero-tariff steady state, and our comparison varies only the import-price-setting mechanism. Their characterization of the optimal response as expansionary is relative to strict PPI-inflation stabilization. Our results are consistent with this characterization and sharpen it: the optimal nominal interest rate itself falls under IPT, whereas under PPT in the same SOE the tariff-imposing country raises its nominal interest rate while allowing positive Home PPI inflation.

Werning, Lorenzoni, and Guerrieri [43] show that a tariff on imported intermediate inputs maps exactly into a cost-push shock in the standard closed-economy New Keynesian model, and they characterize the optimal response analytically: rather than keeping inflation at zero, which would require a sharp short-run contraction in output, optimal policy partially accommodates the shock. Their framework isolates the cost-push channel of tariffs on imported inputs; we instead focus on tariffs on final-goods imports, for which expenditure switching and importer pricing shape the optimal policy response. Bianchi and Coulibaly [13] and Werning, Lorenzoni, and Guerrieri thus share the policy implication that strict inflation stabilization is not optimal following a tariff increase, and our results support the same implication. We complement these studies by characterizing the sign of the nominal interest-rate response itself, which is not the object of their analyses.

Bergin and Corsetti [10] study unilateral and reciprocal tariffs in a model with a richer international trade structure, including global value chains and firm dynamics, and investigate alternative pricing behaviors. Assuming monetary cooperation, they find that the tariff-imposing country raises its nominal interest rate in response to a unilateral tariff even under LCP, in contrast to the optimal cut in our IPT environment. Their LCP also implies imperfect exchange-rate pass-through into import prices, but there exporting firms set prices in the destination-market currency, whereas under our IPT, local importing firms set sticky *ex-tariff* import prices. They leave noncooperative policy to future work; insofar as we solve the noncooperative game, our analysis takes up this question.[3] For reciprocal tariffs, both their analysis and ours find that optimal monetary policy involves interest-rate cuts. Our analysis additionally compares how the degree of pass-through affects the magnitude of those cuts and the incidence of the ZLB.

In subsequent work, Bergin and Corsetti [11] study, under cooperative Ramsey policy, how exchange-rate adjustment, trade elasticities, and price flexibility shape the stabilization of unilateral tariff shocks. Because the cooperative planner chooses both countries' policies, their analysis spans both groups: the optimal response is driven mainly by monetary expansion in the tariff-targeted economy, while the response of the tariff-imposing economy is modest. When the tariff-imposing country's currency serves as the dominant invoicing currency, the optimal monetary stance of that country is more expansionary than strict PPI targeting; this relative accommodation need not imply a decline in the nominal interest rate from its steady-state level. Their mechanism operates through the incentive to stabilize demand faced by foreign exporters that preset prices in the tariff-imposing country's currency. By contrast, in our model local importing firms set sticky prices, and the HIAC gives the Home Ramsey planner an incentive to cut the nominal interest rate on impact.

Relative to these contributions, our deliberately parsimonious model isolates the role of importer price setting: it compares PPT with IPT, in which local importers set sticky *ex-tariff* import prices, under otherwise identical tariff shocks and Ramsey policy problems. In the baseline, adding sticky

[3] In a simplified analytical version of their model, the Nash and cooperative solutions coincide, and the tariff-imposing country's policy does not respond to its own import tariff.

local-currency importer prices to Monacelli's framework turns the optimal rate increase into a rate cut on impact.

2.2 Pricing Behavior, Pass-Through, and Monetary Stabilization

This paper is also related to the literature on pricing behavior and exchange-rate pass-through. Betts and Devereux [12] and Devereux and Engel [24] show that local-currency price stickiness weakens the short-run pass-through of exchange-rate movements. Devereux and Engel [25] show that the optimal use of exchange-rate flexibility depends on whether prices are set in producer or local currency, while Corsetti, Dedola, and Leduc [20] show that, in response to capital inflows, the sign of the optimal monetary stance depends on the degree of exchange-rate pass-through into import prices. These results motivate our comparison of PPT and IPT. Okano and Eguchi [40] also use LCP in a small-open-economy analysis of fiscal stimulus.

Our analysis is related to the literature on the role of international relative prices and deviations from the LOOP in optimal monetary policy. De Paoli [23] shows that a national planner in a small open economy has an incentive to use international relative prices rather than fully stabilize domestic inflation. Engel [26] shows that under LCP, currency misalignments associated with deviations from the LOOP are inefficient and enter optimal monetary policy. Fujiwara and Wang [32] extend this logic to a noncooperative policy game under LCP. In the SOE without tariffs, the welfare-relevant LOOP gap is zero, as in Engel [26]; a tariff makes it positive. We show that under IPT the LOOP gap can be used to mitigate the distortion caused by an import tariff: the HIAC gives the Ramsey planner an incentive to move the actual LOOP gap toward its welfare-relevant level to mitigate tariff-induced underconsumption of imports.

The dominant-currency-pricing framework of Gopinath et al. [33] offers a complementary explanation of limited exchange-rate pass-through, whereas our model places local importers at the center of the pricing decision. Models with LCP also differ in how the statutory tariff interacts with import-price rigidity. Chen, Devereux, Shi, and Xu [19] impose the import tax on top of a pre-set price under LCP, whereas Farhi, Gopinath, and Itskhoki [29] place border taxes within an LCP price-setting problem. Our specification follows the former convention: the statutory tariff is added to the sticky *ex-tariff* import price, so it passes through to purchaser prices immediately even though exchange-rate pass-through is gradual. Cavallo, Gopinath, Neiman, and Tang [18] document high tariff pass-through at the border together with more limited retail-price adjustment, which also suggests compression of retail margins, and Gopinath, Itskhoki, and Rigobon [34] document incomplete exchange-rate pass-through into U.S. import prices for dollar-priced imports. Flaaen, Hortaçsu, and Tintelnot [30] find substantial consumer-price effects of washing-machine tariffs, including price changes for complementary and domestically produced goods. These studies motivate our distinction between border prices and *ex-tariff* import prices.

2.3 International Policy Interaction and the ZLB

The two-country analysis is related to the literature on international monetary-policy games. Corsetti and Pesenti [21] study the international dimensions of optimal monetary policy, while Bodenstein, Guerrieri, and LaBriola [16] analyze macroeconomic policy games. Faia and Monacelli [28] formulate welfare-maximizing monetary policy in a two-country New Keynesian economy and compare cooperation with a Nash game between national Ramsey planners. Following their formulation of the noncooperative game, we show that the HIAC, identified in the SOE, continues to shape optimal Home monetary policy when Foreign demand and Foreign monetary policy are jointly endogenous. The two-country extension adds the FAC, through which movements in the Foreign LOOP gap and Foreign tariffs alter the international allocation of Home goods and therefore the Home welfare-relevant LOOP gap.

Finally, the paper is related to the literature on the ZLB, including its international dimension (Fujiwara et al. [31]; Bodenstein, Erceg, and Guerrieri [15]) and its interaction with nominal rigidities (Billi and Galí [14]). The role of the ZLB here is different. We do not add a demand

or natural-rate shock to create a liquidity trap. Instead, reciprocal tariffs can make the welfare-maximizing response sufficiently accommodative to exhaust conventional monetary-policy space; in the baseline, this occurs under PPT but not under IPT. Import-price rigidity changes the welfare trade-offs and the size of the desired accommodation.

3 Small Open Economy

This section examines optimal monetary policy in a small open economy (SOE) in response to an increase in the import tariff. We first present the model, formulate the Ramsey problem, and describe the calibration. We then characterize the welfare-relevant law-of-one-price (LOOP) gap and examine the optimal nominal interest-rate responses under perfect pass-through (PPT) and imperfect pass-through (IPT).

3.1 The Model

The SOE model features a representative Home household, monopolistically competitive Home producers, and a monetary authority. The household consumes a constant-elasticity-of-substitution (CES) composite of Home and Foreign goods and trades state-contingent claims with the rest of the world. Home producers use producer-currency pricing (PCP) and Calvo pricing. The government levies an import tariff and rebates tariff revenue lump sum. No employment subsidy is paid to producers.

We consider two environments: PPT and IPT. The PPT environment is the same as in Monacelli [39], with its derivation provided in Online Appendix B.1. Under IPT, local importers use local-currency pricing (LCP) and Calvo pricing. Consequently, *ex-tariff* import prices are sticky in Home currency under IPT, whereas under PPT they equal the border price of imports in Home currency. The LOOP therefore need not hold under IPT, whereas it always holds under PPT. The local-importer pricing structure follows Monacelli [38].

3.1.1 Households and Demand

The Home household's utility function is identical under PPT and IPT and is given by

$$\mathcal{U} \equiv \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \frac{N_t^{1+\varphi}}{1+\varphi} \right), \tag{1}$$

where C_t denotes the composite consumption index, N_t denotes hours of labor, $\beta \in (0,1)$ denotes the subjective discount factor, and φ denotes the inverse Frisch elasticity.

The household-facing *cum-tariff* price of Foreign variety ι is

$$\widetilde{P}_{F,t}^{IPT}(\iota) \equiv P_{F,t}(\iota) + \tau_{M,t}\mathcal{E}_t P_{F,t}^*. \tag{2}$$

Here $\widetilde{P}_{F,t}^{IPT}(\iota)$ denotes the household-facing *cum-tariff* price of Foreign variety ι under the IPT environment, and $P_{F,t}(\iota)$ denotes the *ex-tariff* Home-currency import price of variety ι, that is, the importer's selling price. Since the tariff is levied on the border price of imports in Home currency, $\mathcal{E}_t P_{F,t}^*$, the tariff payment per unit is $\tau_{M,t}\mathcal{E}_t P_{F,t}^*$. The *cum-tariff* purchaser price in Eq. (2) is therefore the sum of the local importer's *ex-tariff* import price and this tariff payment. Here $\mathcal{E}_t$ denotes the nominal exchange rate, defined as the Home-currency price of one unit of Foreign currency, $P_{F,t}^*$ denotes the price of Foreign goods in Foreign currency, and $\tau_{M,t}$ denotes the ad valorem import tariff rate.

Under PPT, the LOOP holds, so that $P_{F,t} = \mathcal{E}_t P_{F,t}^*$ and the *cum-tariff* import price reduces to $(1+\tau_{M,t})P_{F,t}$, as in Monacelli [39]. Under IPT, however, monopolistically competitive local

importers set their own *ex-tariff* import prices, and the LOOP does not generally hold. Hence, under IPT, the *cum-tariff* purchaser price takes the additive form in Eq. (2).[4]

The statutory duty enters the purchaser price directly, consistent with the border-price evidence reported by Cavallo et al. [18]. As in Monacelli [39], Bergin and Corsetti [10], Bianchi and Coulibaly [13], and Werning, Lorenzoni, and Guerrieri [43], the *cum-tariff* price is not sticky. The specification isolates sticky *ex-tariff* importer prices rather than reproducing the limited short-run retail-price pass-through also documented by Cavallo et al. [18]. Conditional demand for variety ι is

$$C_{F,t}(\iota) = \left(\frac{\widetilde{P}^{IPT}_{F,t}(\iota)}{\widetilde{P}^{IPT}_{F,t}} \right)^{-\varepsilon_M} C_{F,t}, \tag{3}$$

where $\varepsilon_M > 1$ is the elasticity of substitution across import varieties, and $\widetilde{P}^{IPT}_{F,t}$ is the aggregate *cum-tariff* import-price index relevant for the Home CPI, defined by

$$\widetilde{P}^{IPT}_{F,t} \equiv \left[\int_0^1 \widetilde{P}^{IPT}_{F,t}(\iota)^{1-\varepsilon_M} d\iota \right]^{1/(1-\varepsilon_M)}. \tag{4}$$

Because the statutory tariff is added to each variety's *ex-tariff* import price rather than applied proportionally, the aggregate *cum-tariff* import-price index under IPT cannot in general be written as $(1+\tau_{M,t})P_{F,t}$. Eqs. (3)–(4) imply

$$\int_0^1 \widetilde{P}^{IPT}_{F,t}(\iota) C_{F,t}(\iota) d\iota = \widetilde{P}^{IPT}_{F,t} C_{F,t}. \tag{5}$$

Home-good demand takes the same CES form as under PPT (see Eq. (B.3)). Aggregate import demand is

$$C_{F,t} = \upsilon \left(\frac{\widetilde{P}^{IPT}_{F,t}}{P^{IPT}_t} \right)^{-\eta} C_t. \tag{6}$$

Here $C_{H,t}$ and $C_{F,t}$ denote Home consumption of Home and Foreign goods, $P_{H,t}$ denotes the Home-currency price of Home goods (the Home PPI), $\eta > 0$ denotes the elasticity of substitution between Home and Foreign goods, and $\upsilon \in (0,1)$ denotes the openness parameter. Under IPT, relative import consumption satisfies

$$\frac{C_{F,t}}{C_{H,t}} = \frac{\upsilon}{1-\upsilon} \left(\frac{\widetilde{P}^{IPT}_{F,t}}{P_{H,t}} \right)^{-\eta}. \tag{7}$$

This equation shows that an increase in the relative *cum-tariff* price of imports reduces relative import consumption. The corresponding relation under PPT is given by Eq. (B.6).

Under IPT, the Home CPI is given by

$$P^{IPT}_t \equiv \left[(1-\upsilon) P^{1-\eta}_{H,t} + \upsilon \left(\widetilde{P}^{IPT}_{F,t} \right)^{1-\eta} \right]^{1/(1-\eta)}. \tag{8}$$

Under PPT, the Home CPI is $P^{PPT}_t \equiv \left[(1-\upsilon) P^{1-\eta}_{H,t} + \upsilon \left(\widetilde{P}^{PPT}_{F,t} \right)^{1-\eta} \right]^{1/(1-\eta)}$, where $\widetilde{P}^{PPT}_{F,t} \equiv (1+\tau_{M,t}) P_{F,t}$.

[4] Chen et al. [19] likewise impose the import tax on top of a pre-set LCP price. An alternative convention places border taxes inside the LCP price-setting problem, as in Farhi et al. [29]; Erceg, Prestipino, and Raffo [27] emphasize more generally that the macroeconomic effects of trade taxes depend on the assumed tax pass-through.

The international risk-sharing condition under IPT is

$$Z_t = C_t \mathcal{G}_t^{IPT}(\cdot). \tag{9}$$

Here $Z_t \equiv \frac{\mathcal{E}_t P_{F,t}^*}{P_{H,t}}$ denotes the *ex-tariff* relative border price of imports, and $\mathcal{G}_t^{IPT}(\cdot) \equiv \frac{P_t^{IPT}}{P_{H,t}}$ denotes the CPI–PPI ratio under IPT. $P_{F,t}^*$ is the Foreign PPI. In the SOE, $P_{F,t}^* = P_t^*$, where P_t^* denotes the Foreign CPI. Under PPT, the LOOP holds, and the corresponding international risk-sharing condition is $S_t = C_t \mathcal{G}^{PPT}(\tau_{M,t}, S_t)$. Here $S_t \equiv \frac{P_{F,t}}{P_{H,t}}$ denotes the *ex-tariff* relative price of imports, and $\mathcal{G}^{PPT}(\tau_{M,t}, S_t) \equiv \frac{P_t^{PPT}}{P_{H,t}}$ denotes the CPI–PPI ratio under PPT.

Define the LOOP gap as $\Psi_t \equiv \frac{\mathcal{E}_t P_{F,t}^*}{P_{F,t}}$. The *ex-tariff* relative price of imports can therefore be written as $S_t = Z_t/\Psi_t$. When the LOOP holds, $\mathcal{E}_t P_{F,t}^* = P_{F,t}$ and hence $\Psi_t = 1$, implying $S_t = Z_t$.

The household's budget constraint is

$$P_{H,t} C_{H,t} + \int_0^1 [P_{F,t}(\iota) + \tau_{M,t} \mathcal{E}_t P_{F,t}^*] C_{F,t}(\iota)\, d\iota + \sum_{h^{t+1}} \xi_{t,t+1}(h^{t+1}|h^t) B_{t+1}(h^{t+1}) = B_t(h^t) + W_t N_t + \mathcal{D}_t + T_t.$$

Here $B_{t+1}(h^{t+1})$ denotes holdings of state-contingent bonds, denominated in Home currency, that pay one unit of currency at $(t+1, h^{t+1})$, and $\xi_{t,t+1}(h^{t+1}|h^t)$ denotes their nominal Arrow–Debreu state price at date t, given the history $h^t \equiv (h_0, \ldots, h_t)$. $B_t(h^t)$ is the payoff of previously purchased claims at history (t, h^t), W_t denotes the nominal wage, $\mathcal{D}_t$ denotes nominal profits, and T_t denotes lump-sum transfers. Substituting Eq. (5) into this budget constraint gives

$$P_t^{IPT} C_t + \sum_{h^{t+1}} \xi_{t,t+1}(h^{t+1}|h^t) B_{t+1}(h^{t+1}) = B_t(h^t) + W_t N_t + \mathcal{D}_t + T_t.$$

This budget constraint has the same form as its PPT counterpart in Eq. (B.7), with P_t^{IPT} replacing P_t^{PPT}; $\mathcal{D}_t$ includes local-importer dividends. The derivation uses the CES expenditure identity $P_{H,t} C_{H,t} + \widetilde{P}_{F,t}^{IPT} C_{F,t} = P_t^{IPT} C_t$. The importer of record remits the statutory duty, and customs revenue is

$$TR_t \equiv \tau_{M,t} \mathcal{E}_t P_{F,t}^* \int_0^1 C_{F,t}(\iota) d\iota. \tag{10}$$

The customs revenue in Eq. (10) is exactly the statutory-duty component paid on the left-hand side of the disaggregated budget constraint and is rebated lump sum through T_t. The *cum-tariff* household import expenditure and lump-sum rebate are also consistent with Bianchi and Coulibaly [13]. The government also pays the time-invariant subsidy τ on the border acquisition cost, so its net lump-sum transfer is

$$T_t = TR_t - \tau \mathcal{E}_t P_{F,t}^* \int_0^1 C_{F,t}(\iota) d\iota.$$

Here τ denotes the subsidy rate paid to local importers; below we set $\tau = 1/\varepsilon_M$. The subsidy receipt $\tau \mathcal{E}_t P_{F,t}^* \int_0^1 C_{F,t}(\iota) d\iota$ is included in importer dividends in $\mathcal{D}_t$, while payment of the subsidy $\tau \mathcal{E}_t P_{F,t}^* \int_0^1 C_{F,t}(\iota) d\iota$ enters T_t with the opposite sign. Thus the statutory tariff is collected from the importer of record, passed through separately to the purchaser in Eq. (2), and returned to the household as a lump-sum rebate.

The household maximizes its utility subject to its budget constraint. The resulting optimality conditions take the same form as under PPT, with the IPT price indices replacing their PPT counterparts (see Eqs. (B.8)–(B.9)). Combining the Euler equations for Home- and Foreign-currency bonds yields, to first order, the UIP condition

$$\hat{\imath}_t = \hat{\imath}_t^* + \mathrm{E}_t e_{t+1} - e_t, \tag{11}$$

where i_t denotes the Home nominal interest rate, that is, the return on the riskless one-period bond, $\hat{\imath}_t \equiv \log(1 + i_t) - \log(1/\beta)$, $\hat{\imath}_t^*$ is defined analogously for the Foreign nominal interest rate i_t^*, which is exogenous in the SOE, and $e_t \equiv \log(\mathcal{E}_t/\mathcal{E})$. Throughout, a variable without a time subscript denotes its value in the zero-tariff steady state.

3.1.2 Production and Pricing Behavior

The IPT environment contains both Home producers and local importers, whereas the PPT environment has no separate local-importer block. The Home producer side is unchanged from the PPT environment. In addition, local importers use LCP and face Calvo rigidity. Their exact nonlinear pricing block is given by Eqs. (12)–(16). The *ex-tariff* import-price index satisfies

$$P_{F,t}^{1-\varepsilon_M} = \theta_M P_{F,t-1}^{1-\varepsilon_M} + (1-\theta_M)\overline{P}_{F,t}^{1-\varepsilon_M}. \tag{12}$$

Here θ_M denotes the importer Calvo non-adjustment probability and $\overline{P}_{F,t}$ denotes the *ex-tariff* reset price. Because $P_{F,t}/P_{H,t} = Z_t/\Psi_t$, the *ex-tariff* relative import price obeys

$$\frac{Z_t}{\Psi_t} = \frac{Z_{t-1}}{\Psi_{t-1}}\frac{\Pi_{F,t}}{\Pi_{H,t}}, \tag{13}$$

where $\Pi_{F,t} \equiv P_{F,t}/P_{F,t-1}$ and $\Pi_{H,t} \equiv P_{H,t}/P_{H,t-1}$ denote gross *ex-tariff* import inflation and gross Home PPI inflation, respectively.

The importer remits $\tau_{M,t}\mathcal{E}_t P_{F,t}^*$ per imported unit and recovers the same statutory duty from the purchaser. Hence the duty drops out of the importer's net operating cash flow but enters the demand faced by a resetting importer. A resetting importer chooses $\overline{P}_{F,t}$ to solve

$$\max_{\overline{P}_{F,t}} \mathrm{E}_t \sum_{k=0}^{\infty} \theta_M^k Q_{t,t+k} \left[\overline{P}_{F,t} - (1-\tau)\mathcal{E}_{t+k}P_{F,t+k}^*\right] C_{F,t+k|t}, \tag{14}$$

where $Q_{t,t+k} \equiv \beta^k \frac{C_t}{C_{t+k}}\frac{P_t}{P_{t+k}}$ denotes the Home household's nominal stochastic discount factor. The importer's reset-price problem has the LCP–Calvo structure of Monacelli [38], augmented with the statutory duty and the steady-state subsidy. This structure is consistent with the low nominal exchange-rate pass-through documented by Gopinath, Itskhoki, and Rigobon [34]. Here $C_{F,t+k|t}$ denotes demand at date $t+k$ for an import variety whose *ex-tariff* price was reset at date t and is given by

$$C_{F,t+k|t} = \left[\frac{\overline{P}_{F,t} + \tau_{M,t+k}\mathcal{E}_{t+k}P_{F,t+k}^*}{\widetilde{P}_{F,t+k}^{IPT}}\right]^{-\varepsilon_M} C_{F,t+k}. \tag{15}$$

The tariff-induced reduction in demand is therefore internalized in the reset-price problem. The exact first-order condition is

$$\mathrm{E}_t \sum_{k=0}^{\infty} \theta_M^k Q_{t,t+k} C_{F,t+k|t} \left[1 - \varepsilon_M \frac{\overline{P}_{F,t} - (1-\tau)\mathcal{E}_{t+k}P_{F,t+k}^*}{\overline{P}_{F,t} + \tau_{M,t+k}\mathcal{E}_{t+k}P_{F,t+k}^*}\right] = 0. \tag{16}$$

We set $\tau = 1/\varepsilon_M$, which removes the steady-state importer markup and implies $\Psi = 1$ in the deterministic zero-tariff, zero-inflation steady state. Thus, the LOOP also holds in that steady state under IPT.

When importer prices are flexible ($\theta_M = 0$), so that $\overline{P}_{F,t} = P_{F,t}$, Eqs. (2) and (3) imply that the effective elasticity of demand with respect to the importer's own *ex-tariff* price is $-\varepsilon_M P_{F,t}/(P_{F,t} + \tau_{M,t}\mathcal{E}_t P_{F,t}^*)$. Because the statutory duty is added outside the importer's own price, a positive tariff lowers this elasticity in absolute value and gives the importer an incentive to raise its *ex-tariff* price. Setting $\theta_M = 0$ in Eq. (16) and using $\tau = 1/\varepsilon_M$ gives

$$\Psi_t^{-1} = \frac{P_{F,t}}{\mathcal{E}_t P_{F,t}^*} = 1 + \frac{\tau_{M,t}}{\varepsilon_M - 1}. \tag{17}$$

The inverse LOOP gap Ψ_t^{-1} is the importer's *ex-tariff* markup over the border acquisition price. Because the subsidy does not adjust with the tariff, it does not eliminate this tariff-induced increase

in the markup.[5] This opportunistic-pricing effect is closely related to tax pass-through under imperfect competition (Delipalla and Keen [22]; Anderson, de Palma, and Kreider [3]; Weyl and Fabinger [44]). In the present setting, the tariff is proportional to the border acquisition price and is added outside the sticky *ex-tariff* import price.

The IPT environment includes the exact importer reset-price condition in Eq. (16).[6] To first order, Eq. (16) implies

$$\pi_{F,t} = \beta \mathrm{E}_t \pi_{F,t+1} + \kappa_M \left(\psi_t + \frac{\tau_{M,t}}{\varepsilon_M - 1} \right), \tag{18}$$

where $\pi_{F,t} \equiv \log \Pi_{F,t}$, $\psi_t \equiv \log \Psi_t$, and $\kappa_M \equiv (1-\theta_M)(1-\beta\theta_M)/\theta_M$. We use Eq. (18) to interpret the results analytically to first order around the zero-tariff steady state, whereas the nonlinear Ramsey computation retains Eq. (16).

Taking logs of Eq. (17) and linearizing around the zero-tariff steady state gives the flexible-importer-price benchmark

$$\psi_t = -\frac{\tau_{M,t}}{\varepsilon_M - 1}.$$

Hence the expression $\psi_t + \tau_{M,t}/(\varepsilon_M - 1)$ on the right-hand side of Eq. (18) is the actual LOOP gap minus its flexible-importer-price benchmark. Import-price inflation depends on this deviation. Thus the tariff term in Eq. (18) reflects the opportunistic *ex-tariff* price increase implied by Eq. (17), not the statutory duty as a net marginal acquisition cost.

3.1.3 Market Clearing

Home goods-market clearing under IPT is

$$Y_t = (1-\upsilon) \left(\frac{P_t^{IPT}}{P_{H,t}} \right)^{\eta} C_t + \upsilon Z_t^{\eta}. \tag{19}$$

As under PPT, Home output equals the sum of demand from Home and Foreign households. In the SOE, Foreign consumption and output are exogenous and constant and are normalized to one; this normalization is also used in Eq. (9).

3.2 Ramsey Policy

For each pass-through environment, the monetary authority is a social planner that chooses a complete contingent plan under commitment, maximizing the Home household's utility in Eq. (1). We solve the Ramsey problem from the *timeless perspective*. The lagged Lagrange multipliers entering the initial Ramsey first-order conditions are initialized at their deterministic steady-state values, rather than reset to zero at the date of the tariff shock.

In the PPT environment, the choice variables are C_t, Z_t, N_t, Y_t, $\Pi_{H,t}$, $\widetilde{p}_{H,t}$, $\mathcal{K}_{H,t}$, $\mathcal{Z}_{H,t}$, $\Delta_{H,t}$, and i_t for $t \geq 0$, where $\widetilde{p}_{H,t}$ denotes the Home producers' optimal reset price relative to the Home PPI, $\mathcal{K}_{H,t}$ and $\mathcal{Z}_{H,t}$ denote the present-value terms in their reset-price condition, and $\Delta_{H,t}$ denotes producer-price dispersion (see Online Appendix B).[7]

In the IPT environment, the choice variables are C_t, Z_t, N_t, Y_t, $\Pi_{H,t}$, $\widetilde{p}_{H,t}$, $\mathcal{K}_{H,t}$, $\mathcal{Z}_{H,t}$, $\Delta_{H,t}$, Ψ_t, $\Pi_{F,t}$, $\overline{P}_{F,t}$, $\widetilde{P}_{F,t}^{IPT}$, $\mathcal{G}_t^{IPT}$, $P_{H,t}$, and i_t for $t \geq 0$.[8]

[5] The derivation is given in Online Appendix B.2.

[6] The producer conditions are given by Eqs. (B.11)–(B.15). For equations with a B-prefix, see Online Appendix B.

[7] The constraints are Eqs. (B.4), (B.8), (B.9), and (B.10) with $\Psi_t = 1$, Eqs. (B.11)–(B.15), Eq. (B.1), Eq. (B.17) with $\Psi_t = 1$, and the ZLB conditions in Eq. (20).

[8] The constraints include Eqs. (2)–(4), Eqs. (6) and (8), Eqs. (B.8) and (B.9) with P_t^{IPT} replacing P_t^{PPT}, Eq. (9), Eqs. (B.11)–(B.15), Eqs. (12), (13), (15), and (16), Eq. (19), and the ZLB conditions in Eq. (20). The local *ex-tariff* import price $P_{F,t} = (Z_t/\Psi_t)P_{H,t}$ follows from the LOOP-gap identity and is not chosen independently. The CPI–PPI ratio $\mathcal{G}_t^{IPT}$ and the Home PPI $P_{H,t}$ are chosen subject to their exact defining identities in Online Appendix D.1.2.

The ZLB imposes the feasibility, non-negativity, and complementary-slackness conditions

$$i_t \geq 0, \qquad \mu_{i,t} \geq 0, \qquad \mu_{i,t} i_t = 0. \tag{20}$$

Here $\mu_{i,t}$ denotes the Kuhn–Tucker multiplier on the ZLB constraint.[9] The second-order welfare cost functions below are used to interpret the Ramsey policy, not as the planner's objective.

3.3 Calibration and Shocks

The baseline calibration follows Monacelli [39] wherever the model has a direct counterpart. For the importer parameters, which have no counterpart there, we set $\varepsilon_M = \varepsilon$ and $\theta_M = \theta$, following Monacelli [38]; Appendix A examines sensitivity to θ and θ_M. Table 1 summarizes the baseline parameterization.

Table 1: Baseline Calibration

Parameter	Value	Interpretation
β	0.99	Discount factor
υ	0.3	Openness / Home Bias parameter
φ	2.2	Inverse Frisch elasticity
η	1.5	Home–Foreign substitution elasticity
ε	3.8	Elasticity across producer varieties
θ	0.8	Producer Calvo parameter
ε_M	3.8	Elasticity across importer varieties
θ_M	0.8	Importer Calvo parameter
ρ_τ	0.7	Tariff persistence

The tariff process is

$$\tau_{M,t} = \rho_\tau \tau_{M,t-1} + \epsilon_{\tau,t},$$

where $\rho_\tau = 0.7$ follows Monacelli [39].[10] We set the one-time innovation $\epsilon_{\tau,0} = 0.20$, following Monacelli [39], as our baseline.[11] Thus the import tariff rises by 20 percentage points on impact. The steady-state tariff is zero. The deterministic steady-state quarterly nominal interest rate is $1/\beta - 1 = 1.0101$ percent, approximately four percent annualized. Hence a response of -101.01 basis points relative to steady state places the actual nominal rate exactly at the ZLB.

3.4 Welfare-Relevant LOOP Gap

The period welfare cost functions obtained from a second-order approximation to the Home household's utility function identify the planner's welfare-relevant targets. Under PPT, the period welfare cost function is

$$\mathcal{L}_t^{SOE,PPT} \equiv \frac{1}{2}\left[\Lambda_y^{SOE,PPT}(y_t - y_t^{w,SOE,PPT})^2 + \Lambda_{\pi,H}^{SOE,PPT}\pi_{H,t}^2\right], \tag{21}$$

[9] The Ramsey Lagrangians for PPT and IPT are reported in Online Appendix D, and the corresponding first-order conditions in Online Appendix E. The numerical policy paths are obtained from these nonlinear Ramsey first-order-condition systems using Dynare's perfect-foresight solver with its mixed-complementarity algorithm (`lmmcp`) to impose the ZLB. The ZLB is imposed in all experiments except the price-rigidity grid in Appendix A and the notional solutions, which are computed without it.

[10] The value $\rho_\tau = 0.7$ is consistent with the estimates of Schmitt-Grohé and Uribe [41], who find that transitory U.S. import-tariff shocks, which account for most postwar tariff movements, have a half-life of about two quarters. Barattieri, Cacciatore, and Ghironi [9] set the quarterly persistence of tariff shocks to 0.56, based on a panel VAR for SOEs, a value also adopted by Bergin and Corsetti [10].

[11] Throughout the paper, "baseline" refers to the parameter values in Table 1 together with the tariff innovation $\epsilon_{\tau,0} = 0.20$.

where $y_t \equiv \log\left(\frac{Y_t}{\bar{Y}}\right)$ and $\pi_{H,t} \equiv \log \Pi_{H,t}$. Here $y_t^{w,SOE,PPT}$ denotes the welfare-relevant output under PPT, and $y_t - y_t^{w,SOE,PPT}$ denotes the corresponding welfare-relevant output gap. Under IPT, the period welfare cost function is

$$\begin{aligned}\mathcal{L}_t^{SOE,IPT} \equiv \frac{1}{2}\Big[&\Lambda_y^{SOE,IPT}(y_t - y_t^{w,SOE,IPT})^2 + \Lambda_\psi^{SOE,IPT}(\psi_t - \psi_t^{w,SOE,IPT})^2 \\ &+\Lambda_{\pi,H}^{SOE,IPT}\pi_{H,t}^2 + \Lambda_{\pi,F}^{SOE,IPT}\pi_{F,t}^2\Big],\end{aligned} \tag{22}$$

where $y_t^{w,SOE,IPT}$ denotes the welfare-relevant output under IPT, $y_t - y_t^{w,SOE,IPT}$ denotes the corresponding welfare-relevant output gap, $\psi_t^{w,SOE,IPT}$ denotes the welfare-relevant LOOP gap, and $\psi_t - \psi_t^{w,SOE,IPT}$ denotes the welfare-relevant LOOP-gap deviation. Derivations of Eqs. (21) and (22), together with the welfare-relevant variables $y_t^{w,SOE,PPT}$, $y_t^{w,SOE,IPT}$, and $\psi_t^{w,SOE,IPT}$, are provided in Online Appendix F. The coefficients Λ denote welfare weights, which are functions of the structural parameters; their expressions are given in Online Appendix F.1, and Table 2 reports their baseline values. Using complete international risk sharing and Home goods-market clearing, we eliminate the (logarithmic) *ex-tariff* relative border price $z_t \equiv \log\left(\frac{Z_t}{\bar{Z}}\right)$ from the welfare cost functions.[12] Eq. (21) contains no separate relative-price term, whereas Eq. (22) retains the welfare-relevant LOOP-gap deviation and the import-inflation term.

The welfare-relevant LOOP gap in the SOE is given by

$$\psi_t^{w,SOE,IPT} = \Gamma_{\text{own}}^{SOE}\tau_{M,t}, \tag{23}$$

where $\Gamma_{\text{own}}^{SOE}$ denotes the structural loading of the Home import tariff on the welfare-relevant LOOP gap. Under the baseline parameterization, $\Gamma_{\text{own}}^{SOE} = 0.421$. To understand why the welfare-relevant LOOP gap rises in response to an import tariff, we log-linearize Eq. (7), using Eq. (2) and the definition of Ψ_t, around the zero-tariff steady state to obtain

$$c_{F,t} - c_{H,t} = -\eta(z_t + \tau_{M,t} - \psi_t), \tag{24}$$

with $c_{H,t} \equiv \log\left(\frac{C_{H,t}}{\bar{C}_H}\right)$ and $c_{F,t} \equiv \log\left(\frac{C_{F,t}}{\bar{C}_F}\right)$. Eq. (24) shows that an increase in the import tariff raises the *cum-tariff* relative price of imports, thereby inducing an inefficiently low level of import consumption relative to Home-goods consumption and reducing welfare. For a given (logarithmic) *ex-tariff* relative border price z_t, an increase in the LOOP gap ψ_t lowers the *cum-tariff* relative price of imports and offsets this distortion. Consequently, the welfare-relevant LOOP gap rises with the tariff, as shown above, to mitigate the tariff-induced underconsumption of imports (Fig. 1). We call this mechanism the Home Import-Allocation Channel (HIAC), which provides the Ramsey planner with an incentive to raise the actual LOOP gap toward its welfare-relevant level.

While an increase in the LOOP gap puts upward pressure on *ex-tariff* import inflation, as shown in Eq. (18), Calvo price rigidity slows the adjustment of import prices to a nominal depreciation, which raises the Home-currency border price $\mathcal{E}_t P_{F,t}^*$. Consequently, a nominal depreciation can raise the actual LOOP gap despite the importers' incentive to increase their *ex-tariff* import prices. The Ramsey planner can thus exploit import-price stickiness to move the actual LOOP gap toward its welfare-relevant level and thereby alleviate this distortion.

Substituting Eq. (23) into Eq. (22), the welfare-relevant LOOP-gap deviation becomes $\psi_t - \Gamma_{\text{own}}^{SOE}\tau_{M,t}$. Since $\Gamma_{\text{own}}^{SOE} > 0$, an increase in the import tariff raises the welfare-relevant LOOP gap. Given $\Lambda_\psi^{SOE,IPT} > 0$, increasing the actual LOOP gap when it lies below its welfare-relevant level reduces the welfare cost by narrowing the welfare-relevant LOOP-gap deviation. Together with Eq. (24), this establishes the welfare rationale for the HIAC: a higher LOOP gap mitigates tariff-induced underconsumption of imports.

Engel [26] interprets deviations from the LOOP under LCP as currency misalignment and a source of welfare loss. In our setting, log-linearizing the definition of the LOOP gap yields

$$\psi_t = e_t + p_{F,t}^* - p_{F,t},$$

[12] Online Appendix F.2 reports the welfare cost functions with z_t retained.

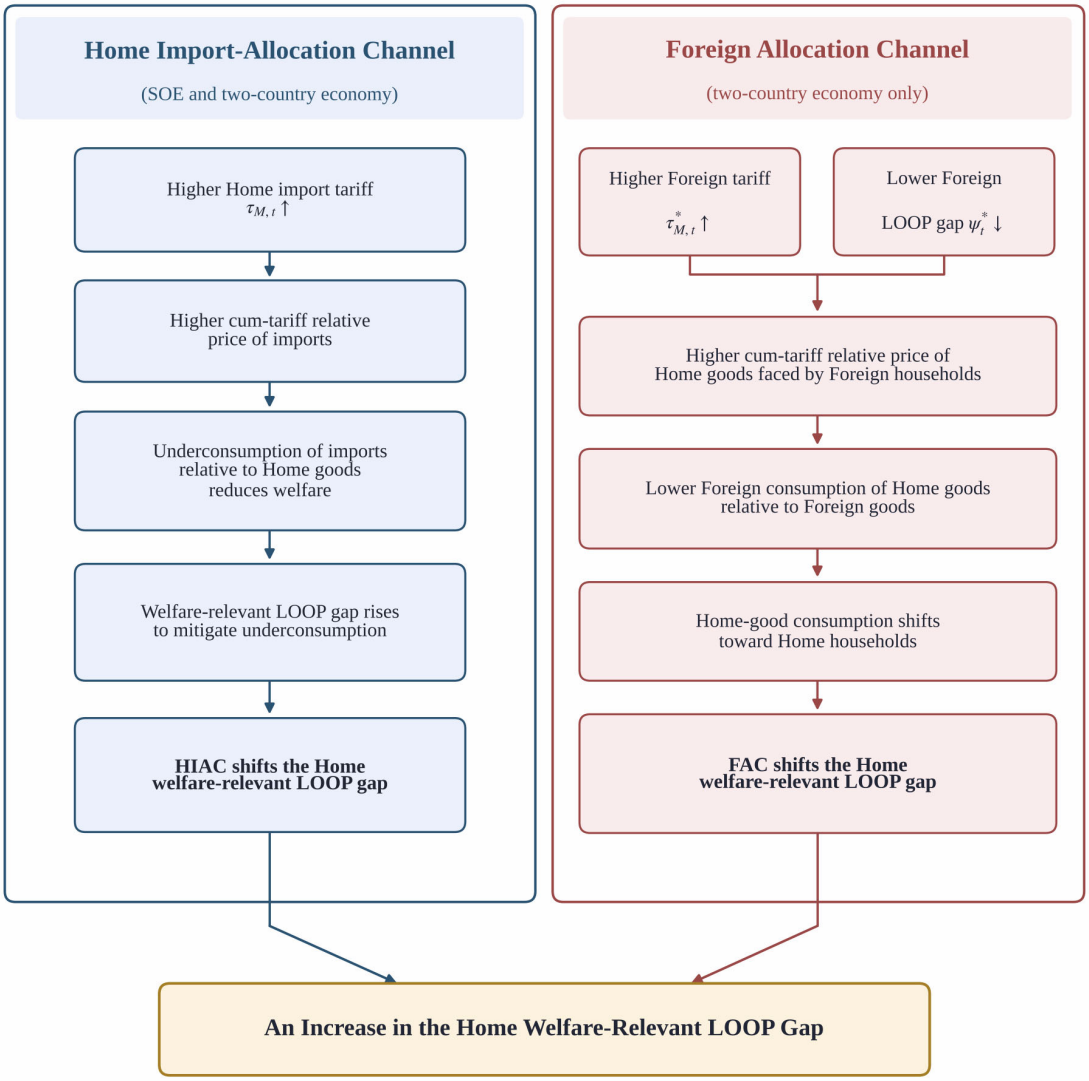


Figure 1: Home Import-Allocation Channel, Foreign Allocation Channel, and the increase in the Home welfare-relevant LOOP gap

Note: The HIAC operates in both the SOE and the two-country economy, whereas the FAC arises only in the two-country economy.

Table 2: SOE Welfare Weights: Baseline Values

Environment	Welfare-Relevant Variable	Weight	Value
PPT	$y_t - y_t^{w,SOE,PPT}$	$\Lambda_y^{SOE,PPT}$	1.654
	$\pi_{H,t}$	$\Lambda_{\pi,H}^{SOE,PPT}$	39.378
IPT	$y_t - y_t^{w,SOE,IPT}$	$\Lambda_y^{SOE,IPT}$	1.654
	$\psi_t - \psi_t^{w,SOE,IPT}$	$\Lambda_\psi^{SOE,IPT}$	0.506
	$\pi_{H,t}$	$\Lambda_{\pi,H}^{SOE,IPT}$	39.378
	$\pi_{F,t}$	$\Lambda_{\pi,F}^{SOE,IPT}$	27.295

Note: All entries are rounded evaluations of the structural welfare coefficients derived in Online Appendix F.1; the unrounded values are retained in the second-order calculation.

with $p_{F,t} \equiv \log(P_{F,t}/P_F)$ and $p^*_{F,t} \equiv \log(P^*_{F,t}/P^*_F)$. Define the welfare-relevant nominal exchange rate by

$$e_t^{w,SOE,IPT} \equiv p_{F,t} - p^*_{F,t} + \psi_t^{w,SOE,IPT}. \tag{25}$$

It follows immediately that

$$\psi_t - \psi_t^{w,SOE,IPT} = e_t - e_t^{w,SOE,IPT}. \tag{26}$$

Hence, following Engel's currency-misalignment interpretation, reducing the welfare-relevant LOOP-gap deviation is exactly equivalent to reducing the nominal exchange-rate misalignment, measured by the deviation of the actual nominal exchange rate from the welfare-relevant nominal exchange rate.

Eq. (25) implies that, for given *ex-tariff* import prices, an increase in the welfare-relevant LOOP gap raises the welfare-relevant nominal exchange rate, providing the Ramsey planner with a welfare-based incentive to induce nominal depreciation. For a given future nominal exchange rate and Foreign nominal interest rate, UIP in Eq. (11) implies that inducing such depreciation requires a reduction in the Home nominal interest rate. Import-price stickiness under IPT allows nominal depreciation to affect the actual LOOP gap.

Eq. (24) can be rewritten as

$$c_{F,t} - c_{H,t} = -\eta \left(p_{F,t} + \tau_{M,t} - p_{H,t} \right),$$

where $p_{H,t} \equiv \log(P_{H,t}/P_H)$. For a given z_t, a higher LOOP gap therefore corresponds to a lower *ex-tariff* relative price of imports, $p_{F,t} - p_{H,t}$. Because $p_{F,t}$ is sticky under IPT, this is consistent with an increase in the Home PPI resulting from a rate cut. As the expression above shows, this increase in the Home PPI puts upward pressure on relative import consumption, $c_{F,t} - c_{H,t}$. Hence, a higher LOOP gap helps mitigate the underconsumption of imports. This does not mean that the rate cut reflects tolerance of Home PPI inflation. The weights on the output gap and Home PPI inflation are identical under PPT and IPT (Table 2), yet the Ramsey planner raises the nominal interest rate under PPT. What distinguishes IPT is the welfare-relevant LOOP-gap term in Eq. (22); the increase in the Home PPI is its counterpart in terms of prices.

Under PPT, tariffs likewise induce underconsumption of imports by shifting expenditure toward Home goods. However, a reduction in the nominal interest rate does not provide the same mechanism for mitigating this distortion as under IPT. Through UIP, a rate cut exerts depreciation pressure on the Home currency, tending to raise the Home-currency *ex-tariff* border price of imports. Under PPT, the LOOP holds, so that $P_{F,t} = \mathcal{E}_t P^*_{F,t}$. Consequently, the *ex-tariff* import price adjusts one-for-one with the border price, and nominal depreciation tends to raise the relative price of imports for a given Home PPI. Thus, nominal depreciation cannot mitigate tariff-induced underconsumption of imports through this channel. Under the baseline calibration, the Ramsey planner instead raises the nominal interest rate to counteract upward pressure on Home PPI inflation. This is consistent with the absence of the HIAC under PPT.

3.5 Nominal Interest Rate Response to an Increase in the Import Tariff

Figure 2 compares the optimal responses under IPT and PPT to a 20-percentage-point increase in the Home import tariff. The solid blue lines represent IPT responses, and the dotted green lines represent PPT responses. The central result is that the Home Ramsey planner *lowers* the nominal interest rate under IPT, whereas it *raises* the rate under PPT (Panel 1). On impact, the policy rate falls by 32.87 basis points under IPT and rises by 17.03 basis points under PPT.[13]

Under IPT, an increase in the Home import tariff raises the *cum-tariff* relative price of imports, inducing inefficient underconsumption of imports relative to Home goods (Panel 8 of Fig. 2). As

[13] With $\theta = \theta_M = 0.75$, the benchmark values in Monacelli [38], the impact response is -32.04 basis points under IPT and $+17.76$ basis points under PPT; see Online Appendix I.4. With $\rho_\tau = 0.9$, the impact response is -32.98 basis points under IPT and $+0.84$ basis points under PPT; see Online Appendix I.3.

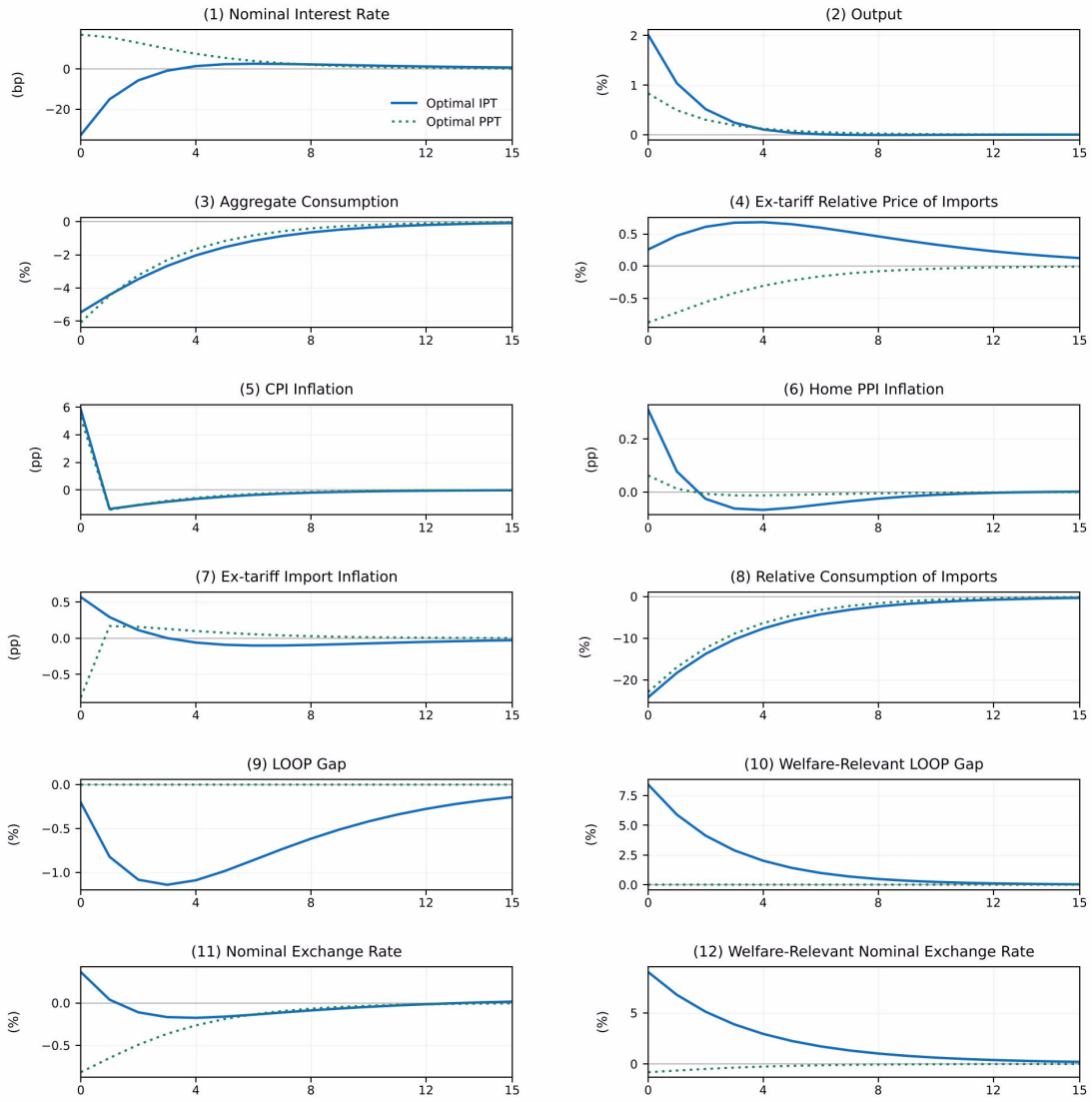


Figure 2: SOE: optimal PPT and IPT responses to a 20-percentage-point Home import tariff. Panel 1 reports the nominal interest-rate deviation from steady state in basis points; Panel 8 reports the percentage deviation of relative import consumption from steady state; other responses are in percent or percentage points. Under PPT, the LOOP holds identically. In Panel 12, under PPT the actual nominal exchange rate coincides with the welfare-relevant nominal exchange rate, so the PPT series does not represent a separate welfare-relevant target.

explained in Sec. 3.4, the tariff raises the welfare-relevant LOOP gap (Panel 10 of Fig. 2). The HIAC thus gives the Ramsey planner an incentive to move the actual LOOP gap toward its welfare-relevant level. The planner cuts the nominal interest rate to exert depreciation pressure and reduce the welfare-relevant LOOP-gap deviation (Panels 1 and 11 of Fig. 2), subject to the objectives of stabilizing Home PPI inflation and *ex-tariff* import inflation (Panels 6 and 7 of Fig. 2).

Despite this rate cut, the actual LOOP gap falls while the welfare-relevant LOOP gap rises (Panels 9 and 10 of Fig. 2). The rate cut is accompanied by nominal depreciation on impact (Panel 11 of Fig. 2), reflecting the Ramsey planner's incentive to raise the actual LOOP gap toward its welfare-relevant level. Eq. (26) shows that the welfare-relevant LOOP-gap deviation equals

the deviation of the actual nominal exchange rate from the welfare-relevant nominal exchange rate. On impact, the welfare-relevant nominal exchange rate depreciates more than the actual nominal exchange rate (Panels 11 and 12 of Fig. 2). Thus, optimal policy does not fully close that deviation. Further monetary easing, however, would raise both Home PPI inflation and *ex-tariff* import inflation. The planner therefore limits the interest-rate cut and the associated nominal depreciation, which is insufficient to offset the increase in importers' *ex-tariff* import prices. This increase partly reflects the opportunistic-pricing effect. Under the tariff-indexed importer subsidy in Eq. (A.4), which removes this effect, the actual LOOP gap rises on impact, and the Ramsey planner still cuts the nominal interest rate, by 27.90 basis points on impact, compared with 32.87 basis points under the fixed subsidy; the rate then remains below its steady-state level over the first 20 quarters (Online Appendix I.5).[14]

Under PPT, import prices adjust with the nominal exchange rate, so the LOOP holds and there is no scope for minimizing the welfare-relevant LOOP-gap deviation. The increase in the *cum-tariff* relative price of imports shifts spending toward Home goods (see Eq. (B.6)). Relative import consumption therefore declines even under PPT (Panel 8). This expenditure switching raises Home demand and real marginal cost, putting upward pressure on Home PPI inflation. Given the large weight on PPI inflation stabilization in Eq. (21) and Table 2, the PPT planner raises the nominal interest rate, in contrast to the IPT planner (Panel 1).[15]

Relative import consumption falls by more under IPT than under PPT, because importers raise their *ex-tariff* markups under IPT and the Home currency appreciates under PPT. The relevant benchmark for the HIAC, however, is IPT with flexible import prices, which is equivalent to PPT with the tariff in Eq. (A.3) (Proposition 2). Against this benchmark, the underconsumption of imports is mitigated: relative import consumption falls by 24.19 percent on impact under IPT, compared with 29.03 percent with flexible import prices (Online Appendix H.2). With flexible import prices, the Ramsey planner instead raises the nominal interest rate, by 21.49 basis points on impact. Following Monacelli [39], we also examine the High Substitution Case ($\eta = 3$). We find that a nominal interest-rate cut remains optimal under IPT (see Online Appendix I.1.1).[16]

4 Two-Country Economy

The SOE analysis in Sec. 3 identifies the HIAC in the Home Ramsey response to a unilateral tariff, taking the Foreign economy as given. In a two-country economy, however, Foreign monetary policy also responds to the tariff shock and influences the exchange rate and the Home LOOP gap. To examine whether the optimal interest-rate cut under IPT carries over to this setting, we endogenize the Foreign economy and solve for noncooperative Ramsey policies. We study noncooperative rather than cooperative policies because our question concerns the optimal policy of the tariff-imposing country, and a unilateral tariff is itself a noncooperative policy. The two-country extension also allows us to analyze reciprocal tariffs and ZLB episodes.

4.1 The Model

Country size is represented by household mass: households are indexed by $h \in [0, 1]$, with $h \in [0, \nu)$ in country H and $h \in [\nu, 1]$ in country F. Because steady-state per-capita output is the same in both countries, ν is also Home's share of steady-state world output and is therefore calibrated to Home's share of world gross domestic product (GDP). Producer varieties retain the country-specific unit-continuum normalization used in the SOE. To make country-size accounting transparent in

[14] The cumulative response over the first 20 quarters is -93.40 basis-point-quarters, compared with -32.68 under the fixed subsidy.

[15] If the Home central bank set the nominal interest rate under IPT along the optimal PPT path, the Home welfare loss relative to optimal IPT policy, evaluated from the timeless perspective, would be 2.14×10^{-4} percent of steady-state consumption; see Online Appendix J.

[16] At $\eta = 3$, with all other parameters fixed, the SOE impact response is -47.08 basis points under IPT and $+3.31$ basis points under PPT; see Online Appendix I.1.1 and Fig. I.1.

the bilateral importer block, Home importer varieties are indexed by $\iota \in [0, \nu)$ and Foreign importer varieties by $\iota \in [\nu, 1]$. Importer CES integrals are normalized by the corresponding country mass, ν or $1-\nu$. Thus, the country-size ratios in bilateral goods-market-clearing conditions convert per-capita demand between countries, while the normalized importer integrals represent averages within each importing country. Households are identical within each country, so we continue to write the Home allocation in representative-household form. The Home household retains the preferences in Eq. (1). The Foreign representative household has lifetime utility $\mathcal{U}^*$, defined as in Eq. (1) with Foreign composite consumption C_t^* and labor N_t^* replacing C_t and N_t. The Foreign household maximizes $\mathcal{U}^*$ subject to the starred counterparts of the Home household's constraints and satisfies the corresponding optimality conditions. We retain the SOE notation for Home variables.

Country F now has its own consumption, labor, output, producer prices, producer-price dispersion, and monetary policy. Each country produces a continuum of differentiated goods using the same technology and Calvo producer-pricing structure as in Online Appendix B.1. Home and Foreign have separate monetary authorities with nominal interest rates i_t and i_t^*, respectively, and Home and Foreign governments may levy import tariffs $\tau_{M,t}$ and $\tau_{M,t}^*$, respectively. Tariff revenue is rebated lump sum in the country that collects it. Complete international financial markets link the two national household problems and imply international risk sharing. The UIP condition in Eq. (11) continues to hold, with i_t^* now set by the Foreign monetary authority. Thus, a change in Home monetary policy or import tariffs can affect the Foreign allocation and feed back to Home through the world equilibrium.

Home bias is introduced by scaling each country's expenditure weight on partner-country goods by the common openness parameter υ. Given the country sizes ν and $1-\nu$, the Home and Foreign expenditure weights are $\omega_F = \upsilon(1-\nu)$, $\omega_H = 1-\omega_F$, $\omega_H^* = \upsilon\nu$, and $\omega_F^* = 1-\omega_H^*$. Here ω_F is Home's expenditure weight on Foreign goods and ω_H is Home's expenditure weight on Home goods. Likewise, ω_H^* is Foreign's expenditure weight on Home goods and ω_F^* is Foreign's expenditure weight on Foreign goods. For $\upsilon < 1$, the bilateral import weights are smaller than the corresponding partner-country economic-size shares, generating home bias.

These expenditure weights enter the two national consumption baskets:

$$\begin{aligned} C_t &= \left[\omega_H^{1/\eta} C_{H,t}^{(\eta-1)/\eta} + \omega_F^{1/\eta} C_{F,t}^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)}, \\ C_t^* &= \left[(\omega_F^*)^{1/\eta}(C_{F,t}^*)^{(\eta-1)/\eta} + (\omega_H^*)^{1/\eta}(C_{H,t}^*)^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)}. \end{aligned} \tag{27}$$

where $C_{F,t}^*$ and $C_{H,t}^*$ denote Foreign consumption of Foreign and Home goods, respectively. Bilateral goods-market clearing therefore replaces the SOE assumption that Foreign demand is exogenous.

In the two-country model, the LOOP also holds for Home goods under PPT, so that $P_{H,t} = \mathcal{E}_t P_{H,t}^*$, where $P_{H,t}^*$ denotes the Home-goods price in Foreign currency. The Foreign LOOP gap is defined as $\Psi_t^* \equiv P_{H,t}/(\mathcal{E}_t P_{H,t}^*)$. Under IPT, both Home and Foreign local import prices are sticky, and the LOOP gaps are endogenous. The two national allocations interact through goods-market clearing, international risk sharing, and their respective monetary policies.[17]

4.2 Noncooperative Ramsey Policies

We formulate the two-country policy game following the noncooperative Ramsey approach of Faia and Monacelli [28]. The Home social planner commits to a complete contingent Home plan and maximizes $\mathcal{U}$, taking Foreign consumption as given and excluding the Foreign pricing, Euler, and resource conditions from its constraints. Its constraints are the Home private-equilibrium conditions and the definitions of the price indices of both countries, with international relative prices determined by complete risk sharing. Under IPT, the Home planner therefore takes as given the

[17] The nonlinear equilibrium systems for the two-country model are provided in Online Appendix C, with additional details in Online Appendix C.3.

ex-tariff prices set by Foreign importers, so that it affects the Foreign LOOP gap only through the international relative price. The Foreign social planner symmetrically maximizes $\mathcal{U}^*$. Both countries' nominal interest rates are subject to the ZLB. As in the SOE, both Ramsey problems are solved from the timeless perspective, with lagged national Lagrange multipliers initialized at their respective deterministic steady-state values rather than reset at the date of the tariff shock.

The Ramsey first-order conditions are derived from these nonlinear problems. The resulting Home and Foreign Ramsey first-order-condition systems, together with the common nonlinear two-country private-equilibrium system, are solved jointly, so that each planner's policy is a best response to the other's. This nonlinear Nash–Ramsey fixed point generates all two-country policy paths reported below. In a unilateral-deviation test, each planner's criterion falls when its policy-rate path departs from the Nash path in any of the directions examined (Online Appendix K). The Ramsey Lagrangians and first-order conditions, including the ZLB Kuhn–Tucker conditions, are reported in Online Appendices D and E, respectively; Online Appendix E also describes the numerical implementation.

4.3 Calibration and Shocks

For the two-country numerical evaluation we retain the baseline parameterization in Table 1 and set the Home economic-size share to $\nu = 0.27$ to match the U.S. share of world GDP in 2025 at current prices in U.S. dollars, using the April 2025 International Monetary Fund (IMF) World Economic Outlook Database [37].[18] Together with $\upsilon = 0.30$, this implies Home's import expenditure weight $\omega_F = \upsilon(1-\nu) = 0.219$. This 21.9 percent share is close to the 22.3 percent average ratio of U.S. imports of goods and services to personal consumption expenditures over 2000–2025 [42], although U.S. imports also include intermediate and capital goods. These values are used in the two-country welfare weights and in the baseline-parameterization IRFs reported below.

4.4 Welfare-Relevant LOOP Gap

As in the SOE, the period welfare cost functions obtained from a second-order approximation to the Home household's utility function identify the Home planner's welfare-relevant targets. Under PPT, the Home period welfare cost is

$$\mathcal{L}_{H,t}^{PPT} \equiv \frac{1}{2}\left[\Lambda_y^{PPT}(y_t - y_t^{w,PPT})^2 + \Lambda_z^{PPT}(z_t - z_t^{w,PPT})^2 + \Lambda_{\pi,H}^{PPT}\pi_{H,t}^2\right], \tag{28}$$

whereas under IPT it is

$$\begin{aligned}\mathcal{L}_{H,t}^{IPT} \equiv\ & \frac{1}{2}\Big[\Lambda_y^{IPT}(y_t - y_t^{w,IPT})^2 + \Lambda_{\psi}^{IPT}(\psi_t - \psi_t^{w,IPT})^2 + \Lambda_z^{IPT}(z_t - z_t^{w,IPT})^2 \\ & + \Lambda_{\psi^*}^{IPT}(\psi_t^* - \psi_t^{*,w,IPT})^2 + \Lambda_{\pi,H}^{IPT}\pi_{H,t}^2 + \Lambda_{\pi,F}^{IPT}\pi_{F,t}^2 + \Lambda_{\pi_H^*}^{IPT}(\pi_{H,t}^*)^2\Big],\end{aligned} \tag{29}$$

where $y_t^{w,PPT}$ and $y_t^{w,IPT}$ denote the welfare-relevant output under PPT and IPT, respectively; $z_t^{w,PPT}$ and $z_t^{w,IPT}$ denote the welfare-relevant *ex-tariff* relative border price of imports under PPT and IPT, respectively; ψ_t^* denotes the Foreign LOOP gap; $\psi_t^{*,w,IPT}$ denotes its welfare-relevant value in the Home welfare cost function; and $\pi_{H,t}^* \equiv \log(P_{H,t}^*/P_{H,t-1}^*)$ denotes Foreign *ex-tariff* import inflation. Derivations of Eqs. (28) and (29) and their Foreign counterparts, together with the associated welfare-relevant variables, are provided in Online Appendix F.

Under PPT, the LOOP holds and Home welfare contains no LOOP-gap term. Under IPT, the Home welfare cost includes the Home welfare-relevant LOOP-gap deviation, $\frac{1}{2}\Lambda_{\psi}^{IPT}(\psi_t - \psi_t^{w,IPT})^2$. As in the SOE (Sec. 3.4), the HIAC gives the Home Ramsey planner an incentive to move the actual Home LOOP gap toward the Home welfare-relevant LOOP gap. In the two-country economy, the Home welfare-relevant LOOP gap also depends on the Foreign import tariff, the Foreign LOOP gap, and the international relative price, as shown in Eq. (30).

[18] In the two-country economy, the baseline also includes $\nu = 0.27$.

Table 3 reports the baseline Home welfare weights in the two-country economy. The coefficients on the squared deviations of the (logarithmic) *ex-tariff* relative border price of imports, z_t, from its welfare-relevant level are $\Lambda_z^{PPT} = -0.081$ under PPT and $\Lambda_z^{IPT} = -0.097$ under IPT. Holding the other gaps fixed, the Home welfare cost falls as z_t deviates from its welfare-relevant level, so these terms are not stabilization objectives. They reflect a relative-price externality in the noncooperative Ramsey problem: relative-price movements can shift expenditure toward Home goods, support Home output and income, and thereby improve Home welfare. Restricted to the directions in which the Home planner can move while taking the Foreign plan as given, the Home welfare cost remains convex (see Online Appendix F.3.10).[19]

Table 3: Two-country Home Welfare Weights: Baseline Values

Environment	Welfare-Relevant Variable	Weight	Value
PPT	$y_t - y_t^{w,PPT}$	Λ_y^{PPT}	2.008
	$z_t - z_t^{w,PPT}$	Λ_z^{PPT}	−0.081
	$\pi_{H,t}$	$\Lambda_{\pi,H}^{PPT}$	45.867
IPT	$y_t - y_t^{w,IPT}$	Λ_y^{IPT}	2.860
	$\psi_t - \psi_t^{w,IPT}$	Λ_ψ^{IPT}	0.406
	$z_t - z_t^{w,IPT}$	Λ_z^{IPT}	−0.097
	$\psi_t^* - \psi_t^{*,w,IPT}$	$\Lambda_{\psi^*}^{IPT}$	0.354
	$\pi_{H,t}$	$\Lambda_{\pi,H}^{IPT}$	65.313
	$\pi_{F,t}$	$\Lambda_{\pi,F}^{IPT}$	21.283
	$\pi_{H,t}^*$	$\Lambda_{\pi_H^*}^{IPT}$	13.519

Note: Coefficients are calculated from the structural-parameter expressions in Online Appendix F.3 and rounded to three decimals. Negative relative-price weights reflect the relative-price externality, not a stabilization objective.

The Home welfare-relevant LOOP gap is given by

$$\psi_t^{w,IPT} = \Gamma_{\text{own}} \tau_{M,t} + \Gamma_{\text{cross}} (\tau_{M,t}^* - \psi_t^*) + \Gamma_z z_t, \tag{30}$$

where $\psi_t^* \equiv \log \Psi_t^*$ denotes the (logarithmic) Foreign LOOP gap, and the coefficients Γ_{own}, Γ_{cross}, and Γ_z are functions of the structural parameters given in Online Appendix F.3. The first term on the right-hand side of Eq. (30) represents the HIAC discussed in Sec. 3.4 (Fig. 1). The positive Home-tariff coefficient, $\Gamma_{\text{own}} = 0.364$, reflects the same welfare mechanism as in the SOE: a higher Home LOOP gap mitigates tariff-induced underconsumption of imports by lowering their *cum-tariff* relative price.

The second term on the right-hand side of Eq. (30) represents the Foreign Allocation Channel (FAC). An increase in the Foreign import tariff or a decline in the Foreign LOOP gap raises the *cum-tariff* relative price of Home goods faced by Foreign households, reducing their consumption of Home goods relative to Foreign goods. For given Home output, this shifts the consumption of Home goods toward Home households, inducing inefficient overconsumption of Home goods, or equivalently, relative underconsumption of Foreign goods in Home. As discussed in Sec. 3.4, a higher Home LOOP gap lowers the *cum-tariff* relative price of imports faced by Home households and thereby mitigates this distortion. The Home welfare-relevant LOOP gap therefore rises through the FAC. The positive coefficient, $\Gamma_{\text{cross}} = 0.060$, reflects this mechanism.[20] [21]

[19] The international risk-sharing condition can be used to eliminate z_t from the Home welfare cost function, but doing so introduces the Foreign welfare-relevant output gap. In the SOE, the corresponding Foreign component is exogenous, whereas in the two-country economy, the Foreign welfare-relevant output gap is determined endogenously in the joint equilibrium. We therefore retain z_t explicitly to highlight the relative-price externality in the noncooperative Ramsey problem.

[20] The third term captures the effect of the *ex-tariff* relative border price of imports, z_t, on the Home welfare-relevant LOOP gap. The coefficient $\Gamma_z = -0.016$ reflects the international allocation of Home goods under home bias and two competing incentives in Home producer pricing; Online Appendix F.3.9 decomposes Γ_z into these components.

[21] Online Appendix F.4 gives the Foreign planner's welfare-relevant LOOP gap.

4.5 Nominal Interest Rate Response to an Increase in the Import Tariff

Figure 3 compares the Home IRFs under IPT and PPT to a 20-percentage-point increase in the Home import tariff in the two-country economy.[22] The solid blue lines represent IPT, and the dotted green lines represent PPT. The central finding from the SOE carries over when Foreign monetary policy is endogenous: the Home Ramsey planner cuts the nominal interest rate under IPT (Panel 1). On impact, the Home rate falls by 17.23 basis points under IPT, whereas it rises by 5.27 basis points under PPT.[23] The Home rate cut under IPT is concentrated on impact: the policy rate returns close to its steady-state level in the following quarter, rises above that level in the second quarter after impact, and closely tracks the PPT path from the third quarter onward.[24]

The HIAC remains operative in the two-country economy. As explained in Sec. 4.4, the Home import tariff raises the Home welfare-relevant LOOP gap (Panel 10 of Fig. 3), and the HIAC gives the Home Ramsey planner an incentive to move the actual Home LOOP gap toward it. This incentive contributes to the optimal interest-rate cut under IPT. Nevertheless, the actual Home LOOP gap declines on impact, even though its welfare-relevant level rises (Panels 9 and 10 of Fig. 3). This equilibrium outcome reflects the endogenous response of Foreign monetary policy, as discussed below. Relative import consumption falls by more under IPT than under PPT (Panel 8 of Fig. 3), as in the SOE. Against the relevant benchmark of IPT with flexible import prices ($\theta_M = 0$), however, the underconsumption of imports is mitigated even though the actual Home LOOP gap declines: relative import consumption falls by 23.91 percent on impact under IPT, compared with 27.88 percent with flexible import prices (Online Appendix I.6).[25] With flexible import prices, the Home planner instead raises the nominal interest rate, by 22.37 basis points on impact.

The FAC also operates in the two-country economy, but under a unilateral Home tariff it partly offsets the HIAC. The Home import tariff reduces Foreign export demand by shifting Home expenditure away from Foreign goods. This decline in export demand puts downward pressure on Foreign output and PPI inflation, inducing the Foreign Ramsey planner to cut the nominal interest rate substantially. Under IPT, the Foreign rate cut is close to the Home rate cut on impact and considerably more persistent, and the resulting monetary-policy interaction leads to a nominal appreciation of the Home currency through UIP in Eq. (11) (Panel 11 of Fig. 3 and Panel 1 of Fig. G.1). The appreciation raises the Foreign-currency border price of Home goods, while the prices charged by Foreign importers adjust sluggishly under IPT. Consequently, the Foreign LOOP gap rises on impact. Since the Foreign tariff remains unchanged and $\Gamma_{\text{cross}} = 0.060 > 0$, Eq. (30) implies that the FAC contribution, $-\Gamma_{\text{cross}}\psi_t^*$, is negative, partly offsetting the positive HIAC contribution to the Home welfare-relevant LOOP gap. Nevertheless, the Home welfare-relevant LOOP gap rises on impact.

The difference in Home-currency appreciation between IPT and PPT reflects the monetary-policy responses of both countries. On impact, the Home nominal interest rate is 22.50 basis points lower under IPT than under PPT, whereas the Foreign rate is 41.88 basis points higher. Thus, about two-thirds of the difference in the Home–Foreign interest-rate differential arises from the Foreign side. The Foreign contribution also accounts for more than two-thirds of the cumulative difference over the first 20 quarters. Through UIP, these differences in the anticipated paths of the interest-rate differential explain why the Home-currency appreciation is smaller under IPT than

[22] Online Appendix Fig. G.1 reports the Foreign responses.

[23] With $\theta = \theta_M = 0.75$, the benchmark values in Monacelli [38], the impact Home rate response is -13.60 basis points under IPT and $+6.27$ basis points under PPT; see Online Appendix I.4.

[24] Over the first 20 quarters, the cumulative Home nominal interest-rate response is $+12.50$ basis-point-quarters under IPT and $+45.45$ under PPT, a difference of -32.95 basis-point-quarters. Approximately 97% of this difference arises in the first two quarters. The cumulative IPT–PPT difference is negative at every horizon within the first 20 quarters. The corresponding cumulative Foreign interest-rate responses are -93.95 and -177.38 basis-point-quarters, respectively. Thus, the cumulative Home–Foreign interest-rate differentials are $+106.46$ under IPT and $+222.83$ basis-point-quarters under PPT.

[25] Unlike in the SOE (Proposition 2), this benchmark does not coincide with the PPT equilibrium under the tariff in Eq. (A.3): the private equilibrium conditions coincide, but under IPT each planner takes the other country's *ex-tariff* import prices as given (Sec. 4.2), even when they are flexible.

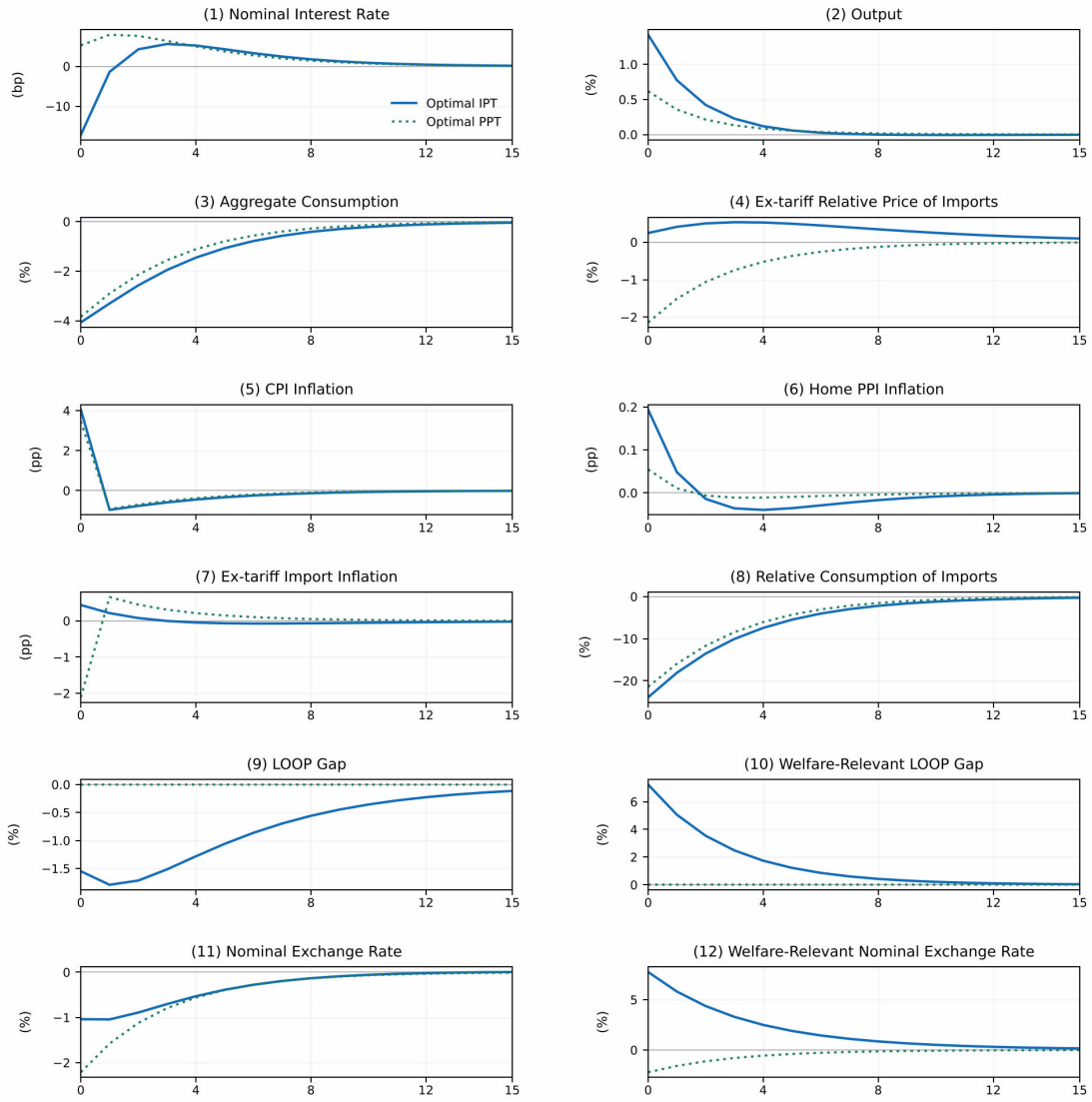


Figure 3: Two-country unilateral tariff: Home responses under optimal PPT and IPT allocations following a 20-percentage-point Home import-tariff shock. Panel 1 reports the Home nominal interest-rate deviation from steady state in basis points and Panel 8 the percentage deviation of relative consumption of imports from steady state. Other deviations and inflation rates are in percent or percentage points. In Panel 12, under PPT the actual nominal exchange rate coincides with the welfare-relevant nominal exchange rate, so the PPT series does not represent a separate welfare-relevant target.

under PPT (Panel 11 of Fig. 3). Thus, in the two-country equilibrium, the HIAC shows up not as a nominal depreciation or a rise in the actual Home LOOP gap, but in the Home rate cut, to which it contributes and which limits the Home-currency appreciation.

Under PPT, the tariff raises the *cum-tariff* relative price of imports, shifting expenditure toward Home goods (Eq. (C.14)). Under the baseline substitution elasticity, the resulting increase in Home demand raises real marginal cost and puts upward pressure on Home PPI inflation. The PPT planner therefore raises the nominal interest rate (Panel 1 of Fig. 3). Hence, in this baseline

experiment, IPT and PPT yield opposite signs of the optimal Home policy-rate response.[26] [27]

4.6 Nominal Interest Rate Responses to Reciprocal Tariffs

This subsection asks how the optimal IPT response changes when both countries levy reciprocal import tariffs. The PPT environment provides a comparison for assessing the role of import pricing. Home and Foreign receive equal, simultaneous shocks to $\tau_{M,t}$ and $\tau^*_{M,t}$; both shocks have persistence $\rho_\tau = 0.7$. All remaining parameters, the two noncooperative Ramsey problems, and the occasionally binding nominal-interest-rate ZLB are those of Sec. 4.

Figure 4 reports the optimal Home responses to simultaneous 20-percentage-point increases in the two import tariffs.[28] Under IPT, the Home planner continues to lower its nominal interest rate, by 75.98 basis points on impact, but the Home rate remains above the ZLB. The Foreign tariff directly reduces Foreign demand for Home goods, while the Home tariff reduces Home demand for Foreign goods. The resulting loss of export demand gives both planners an incentive to ease monetary policy. Under IPT, the HIAC provides an additional incentive for monetary easing by mitigating tariff-induced underconsumption of imports. The export-demand motive is stronger for Home, whose production is more dependent on exports than Foreign production under the baseline country-size calibration.[29] Accordingly, the Home planner eases more strongly than the Foreign planner in both pricing environments (Panel 1 of Fig. 4 and Panel 1 of Fig. G.2). The resulting equilibrium features depreciation in the nominal exchange rate under both PPT and IPT (Panel 11 of Fig. 4), in contrast to appreciation in the nominal exchange rate in the unilateral experiment in Sec. 4.5.

The magnitude of optimal monetary easing, however, depends on import-pricing behavior. Under PPT, exchange-rate movements are fully reflected in import prices, making expenditure switching more pronounced. In particular, Foreign monetary easing induces a stronger shift in Foreign expenditure away from Home goods, increasing the downward pressure on Home export demand. The Home Ramsey planner therefore has a stronger incentive to ease monetary policy to offset this decline. Under IPT, nominal import-price rigidity dampens expenditure switching and reduces the adverse effect of Foreign monetary easing on Home export demand. Consequently, the incentive for additional Home monetary easing is weaker under IPT than under PPT, even though the HIAC provides a separate incentive for a rate cut. Consistent with this mechanism, the optimal degree of monetary easing is smaller under IPT than under PPT.

Under IPT, both the actual Home LOOP gap and its welfare-relevant level rise on impact, reflecting nominal depreciation and the HIAC and FAC, respectively (Panels 9 and 10 of Fig. 4).[30] Under PPT, the LOOP holds identically. The Home nominal interest rate reaches the ZLB for two quarters under PPT, but not under IPT (Panel 1 of Fig. 4). Because the constrained PPT rate is truncated at zero, the observed policy rates understate the difference in the desired degree of monetary easing.

Table 4 reports the minimum *notional* Home nominal interest rate, obtained from the corresponding Ramsey solution without the ZLB constraint. With a 20-percentage-point reciprocal tariff increase, the minimum notional rates are -36.12 basis points under PPT and 25.03 basis points under IPT. These are quarterly nominal interest-rate levels, not deviations from steady

[26] When $\eta = 3$, the impact Home rate responses are -51.35 basis points under IPT and -44.27 basis points under PPT, and Foreign reaches the ZLB under PPT; see Online Appendix I.1.2. With equal country sizes ($\nu = 0.5$), the impact Home rate response is -4.26 basis points under IPT and $+0.03$ basis points under PPT; see Online Appendix I.2. With $\rho_\tau = 0.9$, the impact Home rate response is -23.68 basis points under IPT and -4.41 basis points under PPT; see Online Appendix I.3. Under the tariff-indexed importer subsidy in Eq. (A.4), which removes the opportunistic-pricing effect, the impact Home rate response is -17.44 basis points; see Online Appendix I.5.

[27] If the Home central bank set the nominal interest rate under IPT along the optimal PPT path while the Foreign Ramsey planner continued to optimize, the Home welfare loss relative to the IPT equilibrium, evaluated from the timeless perspective, would be 2.73×10^{-4} percent of steady-state consumption; see Online Appendix J.

[28] For Foreign responses, see Online Appendix Fig. G.2.

[29] With equal country sizes ($\nu = 0.5$), the Home and Foreign nominal interest-rate paths coincide under both PPT and IPT; see Online Appendix I.2.

[30] The corresponding Foreign welfare-relevant LOOP gap is given by Eq. (F.71).

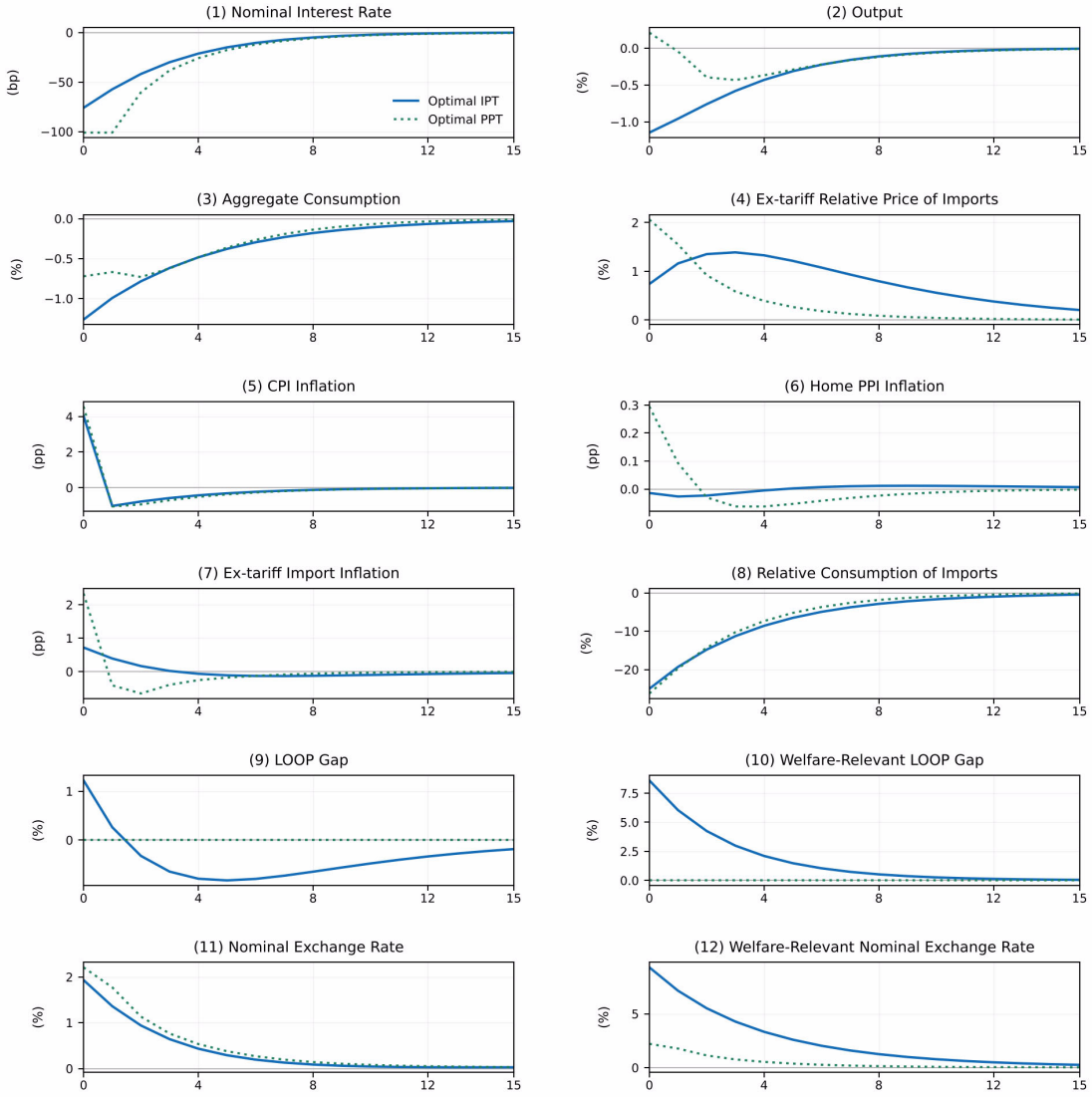


Figure 4: Two-country reciprocal tariffs: Home responses under optimal PPT and IPT allocations following simultaneous 20-percentage-point import-tariff shocks. Panels 1–12 follow the variable selection of the unilateral baseline figure. Panel 1 reports the Home nominal interest-rate deviation from steady state in basis points, Panel 8 is in percent deviation from steady state, and other variables are in percent or percentage points. Under PPT, the ZLB binds at $t = 0$ and $t = 1$. In Panel 12, under PPT the actual nominal exchange rate coincides with the welfare-relevant nominal exchange rate, so the PPT series does not represent a separate welfare-relevant target.

state. Thus the stronger desired easing under PPT pushes the notional rate below zero, so that only the PPT rate is constrained by the ZLB, whereas the weaker desired easing under IPT keeps the notional rate positive. The tariff-rate sensitivity of this result is examined below.[31]

[31]The High Substitution Case for reciprocal tariffs is analyzed in Online Appendix I.1.3. At $\eta = 3$, the Home ZLB episode lasts four quarters under PPT and two under IPT; Foreign reaches the ZLB for two quarters under PPT but not under IPT. The corresponding minimum Home notional rates are -192.18 and -62.06 basis points, respectively.

Table 4: Reciprocal tariffs at $\eta = 1.5$: Home notional rates and ZLB durations

Initial tariff shock (percentage points)	PPT		IPT	
	Min. notional rate (bp)	ZLB quarters	Min. notional rate (bp)	ZLB quarters
5	57.24	0	79.11	0
10	20.58	0	58.57	0
15	-10.21	1	40.41	0
20	-36.12	2	25.03	0

Note: Notional rates are quarterly nominal interest-rate levels, in basis points (not deviations from their steady state); the deterministic steady-state level is 101.01 bp. A ZLB quarter is a quarter in which the constrained optimal nominal interest rate is zero.

ZLB Episodes under Reciprocal Tariffs

To assess how the reciprocal-tariff results vary with the magnitude of the shock, we reduce the initial import-tariff increase in each country from 20 to 15, 10, and 5 percentage points, leaving all other features of the model unchanged. Larger reciprocal tariff shocks generally call for larger Home interest-rate reductions and produce greater Home currency depreciation in both pricing environments.

Table 4 compares the minimum *notional* Home interest rates with the duration of the ZLB in the constrained solutions. At a 10-percentage-point tariff increase, the minimum notional rates remain positive under both PPT (20.58 basis points) and IPT (58.57 basis points), and neither environment generates a ZLB episode. At 15 percentage points, the PPT notional minimum falls to -10.21 basis points, whereas the IPT minimum remains positive at 40.41 basis points. Accordingly, the Home ZLB binds for one quarter only under PPT. With a 20-percentage-point shock, the minima are -36.12 and 25.03 basis points, respectively; the ZLB binds for two quarters under PPT and does not bind under IPT. The notional rates therefore confirm that the need for monetary accommodation is stronger under PPT than under IPT. This ranking holds for every tariff magnitude in Table 4 and in the High Substitution Case (see Online Appendix I.1.3), in contrast to the baseline unilateral experiment, where only IPT calls for a rate cut. It reflects the expenditure-switching mechanism discussed above: under PPT, Foreign monetary easing reduces Foreign demand for Home goods more strongly, so the Home planner has a stronger incentive to ease.

The absence of a ZLB episode for a 10-percentage-point tariff shock is relevant when comparing the 20-percentage-point baseline experiment with the recent U.S. experience. The Budget Lab at Yale [17] estimated that the average effective U.S. tariff rate was approximately 11–12 percent in August 2025, compared with 2.4 percent before the 2025 tariff announcements. The increase in the effective rate was therefore closer to 10 percentage points than to the 20-percentage-point baseline shock. This comparison concerns only the magnitude of the tariff increase: the U.S. effective tariff rate does not measure foreign retaliation, which our experiment assumes to be symmetric.

5 Conclusion

This paper examines the optimal monetary response to import tariffs under IPT. Our central finding is that the optimal initial response under IPT is a rate cut in both the SOE and the two-country economy, whereas under PPT the Ramsey planner in the SOE raises the nominal interest rate.

The HIAC explains the welfare rationale for this result. An increase in the Home import tariff raises the *cum-tariff* relative price of imports, inducing inefficient underconsumption of imported goods relative to Home goods. For a given *ex-tariff* relative border price of imports, a higher LOOP gap raises the price of Home goods relative to the *ex-tariff* import price, thereby partially offsetting

the tariff-induced increase in the *cum-tariff* relative price of imports. The tariff therefore raises the welfare-relevant LOOP gap, giving the Ramsey planner an incentive to raise the actual LOOP gap toward it. Through uncovered interest parity, the depreciation pressure from a rate cut tends to raise the actual LOOP gap under IPT, so monetary easing mitigates the underconsumption of imports, subject to the competing inflation-stabilization objectives.

Under reciprocal tariffs, the loss of export demand leads both countries to cut their nominal interest rates under both PPT and IPT. Under PPT, Foreign monetary easing shifts Foreign expenditure away from Home goods more strongly, increasing the downward pressure on Home export demand, whereas sticky import prices attenuate this expenditure switching under IPT. Thus, in contrast to a unilateral tariff, reciprocal tariffs call for a stronger Home rate cut under PPT than under IPT, even though the HIAC adds an incentive to ease under IPT; the Home nominal interest rate therefore reaches the ZLB more readily under PPT.

Appendix

A Analytical Benchmarks and Price-Rigidity Sensitivity

To isolate the mechanism behind the IPT rate cut, this appendix characterizes the sign of the impact response analytically in two benchmarks, each of which removes one of the two nominal rigidities: producer-price stickiness or import-price stickiness. The first step is an exact property of the nonlinear SOE.

Lemma 1. *In the SOE under IPT, with a constant Foreign price P_F^* and perfect foresight after the tariff innovation, the nonlinear equilibrium satisfies $1 + i_t = \beta^{-1}\mathcal{E}_{t+1}/\mathcal{E}_t$. Hence*

$$\hat{\imath}_0 \equiv \log(1 + i_0) - \log(1/\beta) = e_1 - e_0 = (\psi_1 - \psi_0) + \pi_{F,1}. \tag{A.1}$$

Proof. Since $Z_t = \mathcal{E}_t P_F^*/P_{H,t}$, Eq. (9) gives $C_t P_t^{IPT} = \mathcal{E}_t P_F^*$. Substituting this into the IPT Euler equation yields $(1 + i_t)^{-1} = \beta C_t P_t^{IPT}/(C_{t+1} P_{t+1}^{IPT}) = \beta \mathcal{E}_t/\mathcal{E}_{t+1}$. The last equality in Eq. (A.1) follows from $\psi_t = e_t + p_F^* - p_{F,t}$, which holds because $\Psi = 1$ in the zero-tariff steady state. □

Thus the optimal rate is cut on impact if and only if the Home currency is expected to appreciate between dates 0 and 1. The second step removes producer-price stickiness.

Proposition 1. *Consider the SOE under IPT with flexible producer prices ($\theta = 0$) and the tariff process $\tau_{M,t} = \rho_\tau \tau_{M,t-1} + \epsilon_{\tau,t}$ with $\rho_\tau \in [0, 1)$, hit at date 0 by an unanticipated innovation $\epsilon_{\tau,0} > 0$ from the zero-tariff steady state, with perfect foresight thereafter. Consider the first-order approximation of the nonlinear timeless-perspective Ramsey first-order conditions, and suppose that the ZLB does not bind. Let $Q \equiv Q^{SOE,IPT}$ and $B \equiv B^{SOE,IPT}$ be as in Eq. (F.25), $\Lambda_{\pi,F} \equiv \Lambda_{\pi,F}^{SOE,IPT}$ as in Eq. (F.30), and p_* and k_* as in Eq. (F.2). Define*

$$g \equiv \frac{k_*}{p_* + \varphi}, \qquad \tilde{\Lambda}_\psi \equiv Q_{22} - 2Q_{12}g + Q_{11}g^2,$$
$$\tilde{\Gamma}_{\text{own}} \equiv \frac{B_2 - (B_1 + Q_{12})g + Q_{11}g^2}{\tilde{\Lambda}_\psi}, \qquad \vartheta \equiv \frac{\kappa_M \Lambda_{\pi,F}}{\tilde{\Lambda}_\psi},$$

and let $\delta \in (0, 1)$ be the root of $\beta\delta^2 - (1 + \beta + \kappa_M\vartheta)\delta + 1 = 0$ inside the unit circle. Then

$$\frac{\hat{\imath}_0}{\tau_{M,0}} = -\tilde{\Gamma}_{\text{own}}(1 - \rho_\tau) + \frac{1 - \vartheta}{\vartheta} \frac{(1 - \delta)(1 - \beta\delta)(\delta + \rho_\tau - 1)}{1 - \beta\delta\rho_\tau} \left(\tilde{\Gamma}_{\text{own}} + \frac{1}{\varepsilon_M - 1} \right). \tag{A.2}$$

In particular, the optimal (notional) nominal interest rate falls on impact whenever $\tilde{\Gamma}_{\text{own}} > 0$ and $(\vartheta - 1)(\delta + \rho_\tau - 1) \geq 0$, where

$$\delta + \rho_\tau \geq 1 \iff \kappa_M \vartheta \leq \frac{\rho_\tau(1 - \beta + \beta\rho_\tau)}{1 - \rho_\tau}.$$

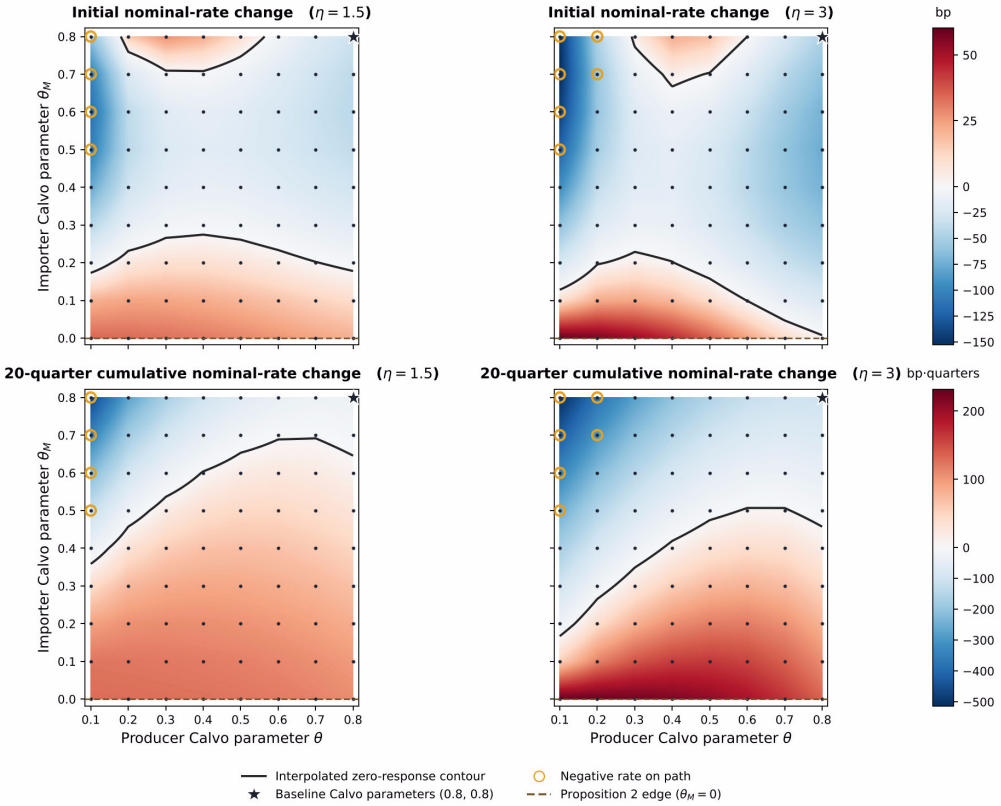


Figure A.1: SOE under IPT: optimal nominal interest-rate responses to a 20-percentage-point Home import tariff across producer- and importer-price stickiness ($\rho_\tau = 0.7$, ZLB not imposed). Top: impact responses (basis points); bottom: 20-quarter cumulative responses (basis-point-quarters). Left: $\eta = 1.5$; right: $\eta = 3$. Dots mark computed parameter combinations; colors and black zero contours are interpolated. The dashed $\theta_M = 0$ row uses the equivalent PPT problem with an effective tariff of 0.2714 (Proposition 2), not the PPT response to a 20-percentage-point tariff. The star marks the baseline $(\theta, \theta_M) = (0.8, 0.8)$; open circles mark nodes at which the notional rate turns negative at some date. Color scales are centered at zero but asymmetric.

Proposition 1 shows that a rate cut can be optimal under IPT even with fully flexible producer prices. The first term in Eq. (A.2) reflects the decay of the tariff-induced welfare-relevant LOOP gap; the second reflects the competing objective of stabilizing import inflation. At the baseline values of the remaining parameters, the sufficient conditions hold for both substitution elasticities. The proof, additional interpretation, and numerical checks are in Online Appendix H.1.

The opposite benchmark removes import-price stickiness instead.

Proposition 2. *Consider the SOE under IPT with flexible import prices ($\theta_M = 0$) and the fixed importer subsidy $\tau = 1/\varepsilon_M$. For any tariff path $\{\tau_{M,t}\}$, the nonlinear Ramsey allocation under IPT, including the nominal-interest-rate path and the ZLB conditions, coincides with the nonlinear Ramsey allocation under PPT for the tariff path $\{\tilde{\tau}_{M,t}\}$, where*

$$\tilde{\tau}_{M,t} \equiv \frac{\varepsilon_M}{\varepsilon_M - 1}\, \tau_{M,t}. \tag{A.3}$$

Proposition 2 is exact. With flexible import prices, Eq. (17) pins down the LOOP gap independently of monetary policy. Hence the tariff-induced underconsumption of imports cannot be

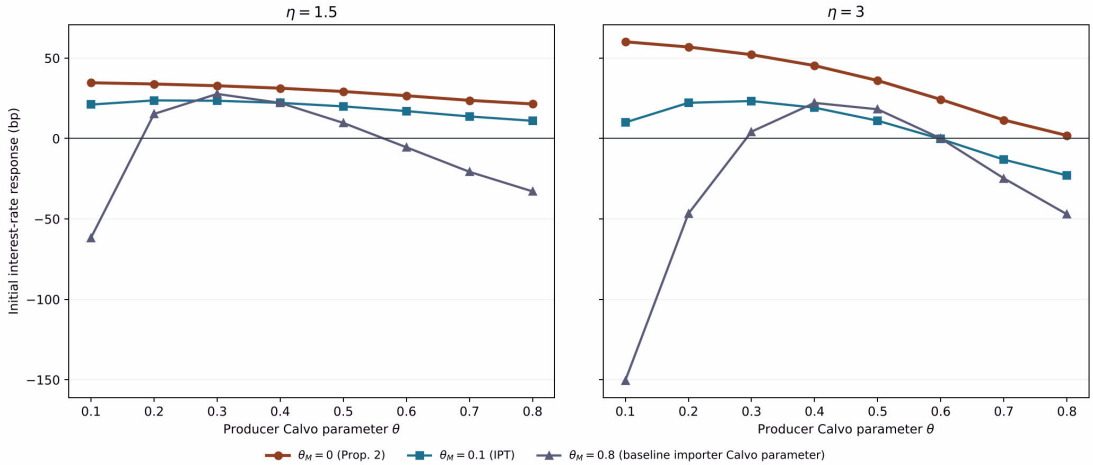


Figure A.2: Initial nominal interest-rate response along three rows of Fig. A.1: $\theta_M = 0$ (Proposition 2, solved as PPT with the effective tariff 0.2714), $\theta_M = 0.1$, and the baseline importer Calvo parameter $\theta_M = 0.8$. Twenty-percentage-point Home import tariff, $\rho_\tau = 0.7$, ZLB not imposed.

mitigated through monetary adjustment of the LOOP gap. The proof and the implications of the fixed importer subsidy are given in Online Appendix H.2, where Corollary 1 also gives the analytical impact response, a sufficient condition for its sign, and its numerical evaluation. At the baseline values of the remaining parameters, the flexible-import-price benchmark implies a positive impact response for both substitution elasticities. To isolate the role of the opportunistic-pricing effect, suppose instead that the importer subsidy is indexed to the tariff,

$$\tau_t = \frac{1 + \tau_{M,t}}{\varepsilon_M}, \tag{A.4}$$

rather than $\tau = 1/\varepsilon_M$. With flexible import prices, Eqs. (16) and (A.4) imply that the LOOP gap equals one, so the opportunistic-pricing effect is absent. With sticky import prices, the initial rate cut under IPT remains (see Online Appendix I.5). The IPT rate cut therefore stems from import-price stickiness rather than from the opportunistic-pricing effect.

Between the Two Benchmarks. Figure A.1 reports the nonlinear Ramsey responses to a 20-percentage-point Home import tariff for a grid of producer- and importer-price rigidity parameters, with $\rho_\tau = 0.7$ and the ZLB not imposed. The figure covers both $\eta = 1.5$ and $\eta = 3$. At $\theta_M = 0$, the results are obtained from the equivalent PPT problem with the tariff scaled as in Proposition 2.

The initial rate cut under IPT is not unconditional. As importer prices become more flexible, the optimal initial response can turn from a rate cut to a rate increase. At $\theta_M = 0$, it is positive for every producer-price rigidity parameter considered in Figs. A.1 and A.2; in the interior, the sign also depends on producer-price rigidity. Thus, the map identifies cases in which weaker importer-price rigidity overturns the baseline rate cut. Figure A.2 makes this transition explicit. When producer prices are highly sticky ($\theta \geq 0.7$), raising importer-price stickiness from $\theta_M = 0$ to the baseline $\theta_M = 0.8$ turns the initial rate increase into a rate cut for both substitution elasticities; along the baseline row, the response is hump-shaped in θ, so that intermediate producer-price stickiness can yield an initial increase. The cumulative responses in the lower panels further show that an initial rate increase need not imply cumulative monetary tightening. Additional grid results and the producer-price rigidity patterns appear in Online Appendix H.3.

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