The Tariff Tax Cut: Tariffs as Revenue*

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Abstract

We study the aggregate effects of a permanent change in tariffs on the US and rest of the world when tariff revenue is used for fiscal reform. Our model combines a standard international model of fiscal policy and a dynamic model of firm entry, exporter dynamics, and tariffs that allows for uncertainty and transitions. We consider both unilateral and cooperative changes in tariffs, and study cases where tariff revenue is (1) rebated lump sum to households, or used to (2) reduce labor taxes, (3) reduce capital taxes, or (4) subsidize investment. We find that with a lump sum rebate, the optimal tariff is negative, even without foreign retaliation, as tariffs worsen existing distortions from markups and taxes. The optimal tariff can be positive when revenue finances a fiscal reform. It is highest (18 percent) when there is no foreign retaliation and revenue is used to subsidize investment, as investment subsidies directly offset the effect of tariffs on investment prices. Estimates of the optimal tariff based on the long run of the model are 50 percent higher than those including the transition and the welfare gains are overstated by more than 100 percent. We also study the Dynamic Tariff Laffer Curve. With gradual substitution toward domestic goods, an increase in tariffs yields more revenue in the short run than in the long run. The tariff that maximizes the present value of tariff revenue is less than half the tariff that maximizes first quarter revenue.

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1 Introduction

How do changes in tariffs affect an already-distorted economy? What is the best way to use the tariff revenue? We study these questions in a quantitative dynamic exporting model with capital and labor taxes, monopolistically competitive producers, an endogenous labor decision, capital accumulation, international borrowing and lending, and roundabout production. We solve for the constant optimal unilateral and cooperative tariffs when tariff revenue is rebated lump sum to households or used to finance other fiscal reforms, including to cut labor or capital taxes or to subsidize investment. In our model, when tariff revenue is rebated lump sum to households, the optimal tariff is negative even without foreign retaliation, as positive tariffs worsen existing distortions. By contrast, the optimal new tariff can be positive if tariff revenue is used for fiscal reform, and it is highest if revenue is used to subsidize domestic investment. We also find that the optimal tariff with lump sum redistribution is quite sensitive to changes in the underlying model, while it remains relatively constant when revenue is used for other reforms.

To study the interactions between tariffs and other fiscal reforms, we extend the dynamic heterogeneous firm trade model to include key features from fiscal policy analysis. The model without the fiscal adjustments has been shown to improve upon static models of trade in capturing the dynamics of trade at the firm and aggregate level, as well as the cross-sectional effects of widespread trade liberalizations (Alessandria and Choi, 2014b; Alessandria and Mix, 2021; Mix, 2023). Our fiscal extension introduces domestic distortionary taxes so that, as is typical of fiscal analysis, agents make savings, investment, and labor supply decisions to maximize welfare subject to taxes on capital and labor income. Agents save by accumulating physical capital, a non-contingent bond traded internationally, and shares in domestic producers. Like many trade models, these domestic producers are monopolists in an intermediate variety, earning a flow of profits. Following Hopenhayn (1992) and Atkeson and Kehoe (2005), domestic producers are created with an upfront investment and are then subject to idiosyncratic shocks. In our model, these shocks are shocks to the fixed cost required for exporting to foreign destinations. With heterogeneity across firms, only some firms invest in market access to export their product. The structure of fixed export cost shocks makes exporting a dynamic decision in the spirit of Baldwin and Krugman (1989); Das et al. (2007); Alessandria and Choi (2014b); Ruhl and Willis (2017); Alessandria et al. (2021), so the decision to export is strongly influenced by current and expected future tariffs. Since households are the owners of firms, the firms' market structure implies that capital income for households combines the returns from physical capital and the profits of intermediate good producers, which include returns to investment in firm creation and export market access. Additionally, the dynamic nature of the export decision implies households gradually substitute away from imports and toward domestically-produced goods after a tariff change, and the speed of substitution depends on the horizon and persistence of the policy, as well as the accompanying fiscal adjustment. Importantly, with monopolistic producers charging markups on goods and endogenous labor and capital, our competitive equilibrium is inefficient with too little entry.[1]

[1] Dixit and Stiglitz (1977) and Bilbiie et al. (2019) discuss the efficiency of entry in a closed economy with the key margins

The production structure of the model reflects producers' inputs and the importance of imported goods in materials, consumption, and investment. Specifically, producers use other intermediates, physical capital, and labor as inputs. Their output is then sold either to other intermediate good producers to use as material inputs or to households and firms for consumption and investment. Modeling materials in production is common in trade models but unusual in fiscal policy analysis. With the roundabout production structure and taxes on imports, the model thus features double marginalization as in Spengler (1950).[2] To capture the varying importance of foreign inputs in the production of the three types of goods, shipping costs in the model depend on the use of the exported good. Goods used in producing investment goods, for example, face lower shipping costs than goods used in producing consumption goods, and trade is therefore more intensive in investment than consumption goods. The higher use of foreign intermediates in investment then implies that higher tariffs increase the price of investment relative to consumption. In other respects, our model calibration is simplified to focus on the fundamental relationship between tariffs and other taxes. The model includes only two countries that are symmetric before the trade policy intervention and are calibrated to match the US economy's trade share, the distribution of trade across good types, and current fiscal policies.

In this framework, we consider four potential ways the government can use tariff revenue after a change in tariffs: (1) give lump sum rebates to households, (2) reduce labor taxes, (3) reduce capital taxes, or (4) subsidize investment in physical capital. These fiscal reforms are motivated by the theory of the second best. In an economy that is already distorted, can the revenue from higher tariffs be used to enact other policies in a welfare-improving way? We answer this question by conducting a horse race of the four competing uses of revenue, comparing simulations of tariff changes under strict assumptions. First, we assume that all tariff revenue is devoted to only one fiscal reform at a time. Second, we assume changes in tariffs are unanticipated, immediate, and permanent. Then, we identify the new tariff level that maximizes household welfare, which we call the "optimal tariff" for that particular use of revenue, though it is more accurately described as a constrained optimal tariff. We find that the optimal tariff is *negative* when revenue is rebated lump sum to households, regardless of whether the foreign country retaliates. This finding differs from a large trade literature, surveyed by Caliendo and Parro (2022), where lump sum-rebated optimal tariffs without retaliation are positive because of terms of trade effects. While these same terms of trade gains exist in our model, tariffs exacerbate distortions already in the model, including taxes and markups, such that the optimal tariff turns negative. When tariff revenue is used to enact other fiscal reforms, the optimal tariff can still be positive, as the costs of raising tariffs from their initial level to generate additional revenue can be smaller than the benefits of using that additional revenue to reduce labor taxes or subsidize investment, for example. In our framework, optimal tariffs, cooperative and unilateral, are highest (2 percent and 18 percent, respectively) when tariff revenue is used to subsidize investment. An investment subsidy is especially beneficial because trade is intensive in investment goods, so the subsidy directly offsets the cost-increasing

here.

[2] Caliendo et al. (2023) emphasize that with roundabout production one would like low import tariffs, echoing the finding of Diamond and Mirrlees (1971).

impacts of the tariffs for investment goods. If we assume instead that imported intermediates are not used for investment, the optimal tariff with investment subsidies is more similar to other revenue uses. Furthermore, optimal tariffs are higher if imports aren't used for investment, as tariffs have a smaller effect on domestic investment.

Having established the welfare effects of tariffs under different assumptions for the use of tariff revenue, we check to see how other distortions in the model matter for the optimal tariff. When tariffs are rebated lump sum, the optimal tariff is very sensitive to removing or changing distortions in the model. Indeed, the optimal unilateral tariff goes from a 6 percent import subsidy in our baseline calibration to 17 percent import tariff when we remove all distortions by setting labor and capital taxes to zero and providing a revenue subsidy to producers that offsets markups. By contrast, when tariff revenue is used to subsidize investment, the optimal tariff is nearly invariant to the removal of various other distortions, ranging from 16 percent to 18 percent in the unilateral case. This finding highlights that when tariffs are assumed to be rebated lump sum, the optimal tariff is quite sensitive to the margins included in the model.

Our welfare analysis, and therefore our constrained optimal tariffs, are based on solving for the transition from policy reforms. Unlike analyses from static models, we can study the impact of these reforms at all horizons.[3] Consistent with prior work in dynamic trade models, we find there is a large gap between welfare estimates that account for the transition and those based on utility in the new steady state. Consequently, we show that basing tariff policy on utility in the new steady state would substantially overstate both the welfare gain and the optimal tariff. For instance, in our baseline case with an investment subsidy the optimal unilateral tariff is 18 percent while the steady state utility-maximizing tariff is 25 percent. This gap reflects that with the features that lead to an increasing trade elasticity over time, tariffs can be less distortionary in the long-run (Alessandria and Choi, 2014b; Alessandria et al., 2021). Moreover, we find transitions can take some time so that near term estimates of the effects on the aggregate economy are quite distant, and often the opposite sign, from those based on steady state analyses.

Relatedly, with trade dynamics, there is a Dynamic Tariff Laffer Curve: Because the short-run trade elasticity is smaller than the long-run trade elasticity, the same tariff generates more revenue in the short run than the long run. In our calibration, for example, the Tariff Laffer curve in the first quarter of the policy change peaks at a unilateral tariff of about 90 percent. The long-run Tariff Laffer Curve, by contrast, peaks at a much lower tariff of around 37 percent. The tariff that maximizes the present value of revenue is 40 percent and raises an additional 42 percent of current GDP. The amount raised is 5 to 10 percent larger with an investment subsidy compared to alternative reforms. The present value of additional tax revenue from the optimal unilateral tariff is equal to 25 percent of current GDP. The dynamics of the Tariff Laffer Curve, and trade dynamics in general, depend on the perceived persistence of the policy. A tariff increase that is

[3]There is much discussion about whether static models should be viewed as short-run or long-run models. Indeed, Costinot and Rodríguez-Clare (2014) state "quantitative trade models are static models that are better equipped to capture the long-run consequences of trade liberalization than short-term dynamics." This is a common view even though analyses of dynamic models show this is not generally true (Alessandria and Choi, 2014b; Alessandria et al., 2021; Mix, 2023) and there can be large gaps between steady state results and welfare gains. For instance, Ignatenko et al. (2025) describe their static model as providing an estimate of the long-run effects of the trade policy.

perceived to be temporary induces less substitution, as exporters hesitate to leave the foreign market only to pay a higher fixed cost to reenter when tariffs retrace. Likewise, temporary tariffs can induce business cycle fluctuations that influence trade and the revenue generated. Indeed, tariffs that are expected to sunset in five years could generate anywhere from 5 percent less to almost 10 percent more revenue over those five years than tariffs that are expected to be permanent, depending on the fiscal use of the revenue.

Our paper relates to several papers that study international dimensions of trade or fiscal policy. For instance, Williams III (1999), Lashkaripour (2021), and Ignatenko et al. (2025) study these effects in a static trade model with endogenous labor and distortionary labor taxes. Carroll and Hur (2023) also study fiscal reforms with tariff revenue but in a heterogeneous agent incomplete markets model without trade dynamics. They also emphasize that using tariff revenue to reduce capital income taxes will offset the contractionary effects of tariffs. Goulder et al. (1983) provide an early analysis of the importance of incorporating international interactions in the evaluation of domestic tax policy. Mendoza and Tesar (1998) study the role of tax reform in a two country neoclassical growth model with a single good. Mendoza and Tesar (2005) build on this framework to study the determination of taxation with commitment. Quadrini and Ríos-Rull (2024) study tax reform in the open economy without commitment and with intangible capital investment. Relatedly, Spencer (2021) studies corporate tax reform of multinationals in multi-country models of firm dynamics and capital accumulation. Our paper also relates to a closed economy literature on fiscal reforms that builds on Auerbach and Kotlikoff (1987) and Prescott (2004). Closest in spirit is the work by Trabandt and Uhlig (2011) in the consideration of tax reforms. Our paper also relates to a large literature on the theory of the second best (Lipsey and Lancaster, 1956; Bhagwati and Ramaswami, 1963). Boadway et al. (1973) studies tariff and commodity tax determination when lump sum taxes are not available. Corden (1984) reviews numerous papers that discuss the use of tariffs for revenue purposes. Our paper contributes to this vast literature with a modern quantitative model that incorporates trade dynamics and with a focus on the tradeoff between tariffs and other taxes within that framework.

Our paper also relates to a large trade literature—summarized by Caliendo and Parro (2022)—on optimal tariffs with and without retaliation. These analyses generally focus on analytical solutions in static general equilibrium models of trade, often with rich heterogeneity across sectors or goods. A contribution of our paper is extending this analysis quantitatively in the presence of macro and trade dynamics, other distortionary taxes, and with using tariff revenue for fiscal reforms other than lump sum redistribution. Several papers have shown that including macro and trade dynamics in a trade model leads to very different aggregate outcomes (Alessandria and Choi, 2014b; Ravikumar et al., 2019; Mix, 2023). Ours is the first to solve for optimal tariffs in a dynamic environment and emphasize the importance of the use of revenue and structure of the model.

The remainder of the paper proceeds as follows. Section 2 presents our model and calibration. Section 3 reports the main results on optimal tariffs, welfare outcomes, and long-run aggregate effects of tariff reforms, along with the sensitivity of our results. Section 4 studies the dynamics of tariff revenue and calculates the

amount of revenue that can be collected. Section 5 concludes.

2 Model

We study trade and fiscal policy in an extension of the multi-country general equilibrium model of Mix (2023). This model builds on the international real business cycle models of Backus et al. (1994) and Alessandria and Choi (2007) to include firm and exporter dynamics, a roundabout production structure, a realistic composition of trade flows across good types, and multiple countries. These features are needed to most accurately capture the aggregate effects of changes in tariffs (Atkeson and Burstein, 2010; Alessandria and Choi, 2014a; Alessandria et al., 2021).[4] Alessandria and Mix (2021) use a version of the model to study the effects of tariff phaseouts in the three GATT rounds. The model has the main features used in tax policy analysis in the closed economy (Prescott, 2004; House and Shapiro, 2006; Trabandt and Uhlig, 2011) and the open economy (Mendoza and Tesar, 1998, 2005).

In the model, the global economy is assumed to have $\mathcal{I}$ regions, indexed by i and j. In what follows, we describe the behavior of agents in each region in detail. We start with the households problem and then move to the intermediate goods producers and the final goods producers.

2.1 Households

Each region i contains a representative household with time endowment $\bar{L}_i$ that chooses how much of that time to spend working L_i. The household also chooses quantities to consume C_i and to invest in either physical capital K_i (with investments in physical capital denoted by X_i) or a risk-free internationally traded bond B_i, which is denominated in the consumption good of country 1. The household's budget constraint is

$$\begin{aligned} P_{Ci}C_i + (1-s_i^I)P_{Ii}I_i + \frac{P_{C1}B_i{}'}{R^B} \leq\ & (1-\tau_i^L)W_iL_i + (1-\tau_i^K)(R_iK_i+\Pi_i) \\ & + \tau_i^K\delta P_{Ii}K_i + P_{C1}B_i - P_{C1}\frac{\phi}{2}(\frac{B_i}{Y_i^N} - \frac{\bar{B}_i}{\bar{Y}_i^N})^2 + T_i \end{aligned} \tag{1}$$

and capital evolves according to

$$K_i' = (1-\delta)K_i + X_i\left[1 - \frac{\psi}{2}\left(\frac{X_i}{X_{i,-1}} - 1\right)^2\right], \tag{2}$$

where the "prime" indicator on K_i and B_i denote quantities taken into the subsequent period; a subscript of -1 denotes the value of a variable in the previous period; P_{Ci} and P_{Ii} denote the region i prices of consumption and physical capital investment; s_i^I is the rate at which the government subsidizes physical capital investment; R_B is the gross return on the risk-free bond; W_i is the nominal wage; R_i is the rental

[4] One might find it convenient to work with an ad-hoc model of trade adjustment based on habit or adjustment costs, but Alessandria et al. (2021) show that the aggregate implications are quite different with these reduced form frictions than the micro founded firm level frictions emphasized here.

rate of physical capital; Π_i denotes profits earned by firms in the economy and rebated to households; T_i is a lump sum transfer to households from the government; τ_i^K is the tax on capital income, including profits; and τ_i^L denotes the labor income tax. In this framework, δ is the depreciation rate of physical capital; and ϕ and ψ determine the convex costs of adjustment in risk-free bond holdings and physical capital investment, respectively. The adjustment cost on risk-free bonds is included for computational reasons, and the cost is evaluated based on the ratio of the value of bonds to nominal GDP Y_i^N relative to the same ratio in the initial equilibrium, denoted by $\bar{B}_i/\bar{Y}_i^N$.

Each period, the household in region i chooses consumption, leisure, and investment in capital and bonds to maximize its expected discounted lifetime utility. The household's problem is expressed recursively as

$$V_i^H(K_i, B_i, S) = \max_{C_i, L_i, X_i, B_i'} \frac{\left[C_i^{\mu}(\bar{L}_i - L_i)^{1-\mu}\right]^{1-\sigma} - 1}{1-\sigma} + \beta \mathbb{E} V_i^H(K_i', B_i', S')$$

subject to 1 and 2, where S is the aggregate state variable; β is the discount rate; $1/\sigma$ is the intertemporal elasticity of substitution; and μ dictates the relative value of consumption and leisure in utility.

2.2 Intermediate Goods Producers

In each region i, there is a continuum of mass N_i of monopolistically competitive firms that produce differentiated goods using labor and capital rented from domestic households and material inputs purchased from domestic material goods producers (discussed in the next section). Firms in region i must pay a sunk cost $f_{e,i}$ denominated in domestic labor to begin producing and survive each period with exogenous probability n_s. Firms within region i all share the same productivity z_i. Conditional on survival, firms may produce for the domestic market at zero cost, but exports to foreign markets are subject to both fixed and variable costs, both of which are heterogeneous across firms and depend on both the firm's export history and stochastic shocks. In particular, non-exporters face higher fixed costs on average than exporters, leading to a delayed response of the extensive margin of trade to changes in trade costs similar to other sunk cost models. Furthermore, new exporters pay higher variable costs than experienced exporters on average. These features of the model parsimoniously capture features of the exporter life cycle from the data: that exporting exhibits strong hysteresis, and that exports grow with export tenure. More generally, these features imply a slower response of trade to changes in trade costs, in line with the trade literature that finds that the trade elasticity increases over time (Baier and Bergstrand, 2007; Baier et al., 2014; Alessandria et al., 2025a).

Export decisions and export costs are determined independently across destinations j. Each period, a firm in region i with export status $e_{ij} \in \{0, 1\}$ in destination j draws a fixed cost κ_{ij} that must be paid (in units of labor) for the firm to export to j in the subsequent period. The fixed cost is drawn from a Generalized Pareto distribution

$$F_{i,e_{ij}}(\kappa) = 1 - \left(1 + \frac{\upsilon\kappa}{f_{e_{ij}}}\right)^{-\frac{1}{\upsilon}}.$$

With $\upsilon < 1$, the expected fixed cost draw of a firm with export status e_{ij} is $f_{e_{ij}}/(1-\upsilon)$. When matching

moments related to exporter entry in calibration, we get $f_0 > f_1$, which implies that non-exporters ($e_{ij} = 0$) draw higher fixed costs on average than exporters ($e_{ij} = 1$).

Variable costs of exporting to destination j also depend on both export history and stochastic shocks. Exports from i to j of intermediates that will be used in the production of a final good G are subject to either a low iceberg cost ξ_{GLij} or a high iceberg cost ξ_{GHij}. All new exporters (defined as firms that export in the current period but not the previous period) face the high iceberg cost. Conditional on continued export participation, firms have a constant probability $1 - \rho$ of switching to the other cost state. As such, new exporters export less than incumbent exporters on average.

As noted above, the iceberg costs on exports depend on the end-use of the export, whether it's used by final goods producers to produce consumption goods $G = C$, investment goods $G = X$, or material goods $G = M$. Heterogeneity in iceberg costs across good types allows the model to capture the relatively high intensity of trade in capital and material goods. Our calibration will map this composition into lower iceberg costs for capital and material goods and higher iceberg costs for consumption goods.

Because export decisions are made independently and we assume that production is constant returns to scale, we can consider the maximization problem of an intermediate goods producer for each destination separately. Let l_{ij}, k_{ij}, and m_{ij} be the inputs of labor, capital, and materials that a firm uses in the production of goods sold to country j, and let p_{Gij} be the price the firm charges for its good, conditional on the buyer's end use of the good G. Let $\xi_{ij} \in \{\infty, H, L\}$ denote the current cost-state of the firm: $\xi_{ij} = \infty$ denotes a non-exporter facing infinite iceberg costs, $\xi_{ij} = H$ denotes an exporter facing a high iceberg cost, and $\xi_{ij} = L$ denotes an exporter facing a low iceberg cost. As discussed previously, the draw of the fixed cost κ_{ij} depends on the firm's current export status e_{ij} where $e_{ij} = 0$ corresponds to non-exporters with cost-state $\xi_{ij} = \infty$, and $e_{ij} = 1$ corresponds to exporters with cost-state $\xi_{ij} \in \{H, L\}$. The recursive maximization problem of this firm in aggregate state S is

$$V_{ij}(\xi_{ij}, \kappa_{ij}; F_{i,e_{ij}}, S) = \max_{e'_{ij}, p_{Gij}, l_{ij}, k_{ij}, m_{ij}} e_{ij} \left[\sum_G p_{Gij} G_{ij}(f) - W_i l_{ij} - R_i k_{ij} - P_{Mi} m_{ij} \right] - W_i e'_{ij} \kappa_{ij} + n_s \mathbb{E} D_i V_{ij}(\xi'_{ij}, \kappa'_{ij}; F_{i,e'_{ij}}, S')$$

subject to the demand functions that arise from CES aggregation of intermediates by final goods producers, which will be discussed in detail in later, and the production function

$$\sum_G \xi_{G\xi_{ij}ij} G_{ij}(f) = z_i (k_{ij}^{\alpha} l_{ij}^{1-\alpha})^{1-\alpha_m} m_{ij}^{\alpha_m},$$

where

$$D_i = \beta \frac{U'_{C_i}}{U_{C_i}} \frac{P_{Ci}}{P'_{Ci}}$$

is the subjective discount factor, $G_{ij}(f)$ is the firm f's exports of goods used for end-use G, P_{Mi} is the

price of materials, α is capital's share of value added in production, and α_m is the material share in total production costs.

The intermediate goods producer's problem can be broken into a static problem—choosing inputs and prices—and a dynamic problem—choosing tomorrow's export status. The static problem's solution is straightforward and common in the literature, as final goods producers' technology is CES. In particular, optimal prices are the familiar constant markup over marginal costs

$$p_{Gij} = \frac{\theta}{\theta - 1}\xi_{G\xi_j ij} MC_i = \frac{\theta}{\theta - 1}\xi_{G\xi_j ij}\frac{1}{z_i}\left(\frac{P_{Mi}}{\alpha_m}\right)^{\alpha_m}\left[\frac{\left(\frac{R_i}{\alpha}\right)^{\alpha}\left(\frac{W_i}{1-\alpha}\right)^{1-\alpha}}{1-\alpha_m}\right]^{1-\alpha_m}. \tag{3}$$

The parameter θ that determines the size of the markup is the elasticity of substitution across varieties from the same source, which enters the intermediate goods producer's problem through the demand functions described later. Given this structure, an exporter's operating profits net of fixed costs depend on an aggregate component and its idiosyncratic exporting technology and is denoted by $\pi_{\xi_{ij} ij}$.

2.2.1 Dynamic exporting decision

A firm that decides to export in the next period not only receives revenue from foreign sales, but also a higher probability of lower fixed and variable costs going forward. Thus, part of the fixed cost paid to export is an investment in further market access. For ease of exposition, let $V_\xi(\kappa) = V_{ij}(\xi_{ij}, \kappa_{ij}; F_{i,e_{ij}}, S)$ for destination j for a firm in cost-state ξ with fixed cost κ and let π_ξ be that firm's optimal operating profits in j net of fixed costs. The dynamic problems for firms of each type can be written as

$$\begin{aligned}
V_\infty(\kappa) &= \max\{-W\kappa + n_s \mathbb{E}DV_H(\kappa'), n_s \mathbb{E}DV_\infty(\kappa')\},\\
V_H(\kappa) &= \pi_H + \max\{-W\kappa + n_s \mathbb{E}D[(1-\rho)V_L(\kappa') + \rho V_H(\kappa')], n_s \mathbb{E}DV_\infty(\kappa')\},\\
\text{and } V_L(\kappa) &= \pi_L + \max\{-W\kappa + n_s \mathbb{E}D[(1-\rho)V_H(\kappa') + \rho V_L(\kappa')], n_s \mathbb{E}DV_\infty(\kappa')\}.
\end{aligned}$$

The decision to export for a firm in cost-state ξ reduces to an evaluation of the fixed cost κ relative to a threshold κ^*_ξ, defined for each cost-state as

$$W\kappa^*_\infty = n_s \mathbb{E}D[V_H(\kappa') - V_\infty(\kappa')], \tag{4}$$

$$W\kappa^*_H = n_s \mathbb{E}D[(1-\rho)(V_L(\kappa') - V_\infty(\kappa')) + \rho(V_H(\kappa') - V_\infty(\kappa')], \tag{5}$$

$$\text{and } W\kappa^*_L = n_s \mathbb{E}D[(1-\rho)(V_H(\kappa') - V_\infty(\kappa')) + \rho(V_L(\kappa') - V_\infty(\kappa')]. \tag{6}$$

To solve for the expectation terms on the right-hand side of equations 4–6, we take the expected difference between the value of exporters of each type and the value of non-exporters. To be specific, let $dV_\xi \equiv \mathbb{E}(V_\xi(\kappa) - V_\infty(\kappa))$. Using the threshold values above, we can write these terms dV_ξ, which show up in the

threshold fixed cost equations, as

$$\begin{aligned} dV_H &= \pi_H - W\left[\int_0^{\kappa_H^*} \kappa dF_1(\kappa) - \int_0^{\kappa_\infty^*} dF_0(\kappa)\right] \\ &\quad + n_s \mathbb{E}D\left[\left[\rho F_1(\kappa_H^*) - F_0(\kappa_\infty^*)\right] dV_H' + (1-\rho)F_1(\kappa_H^*) dV_L'\right] \\ dV_L &= \pi_L - W\left[\int_0^{\kappa_L^*} \kappa dF_1(\kappa) - \int_0^{\kappa_\infty^*} dF_0(\kappa)\right] \\ &\quad + n_s \mathbb{E}D\left[\left[(1-\rho)F_1(\kappa_L^*) - F_0(\kappa_0^*)\right] dV_H' + \rho F_1(\kappa_L^*) dV_L'\right]. \end{aligned}$$

Conditional on being in the same cost state, firms make identical decisions over inputs, prices, and future export status. This model outcome greatly simplifies the state space of the problem as we only need to keep track of the number of firms in each cost-state for each destination, which can be easily derived given the fixed cost thresholds and the distribution of fixed cost draws.

2.2.2 Free entry

Intermediate goods producers exogenously exit the market with probability $1 - n_s$. Each period, there is an unbounded mass of potential firms that may begin producing in the subsequent period by paying fixed cost $f_{e,i}$, denominated in labor. In the first year of production, firms only serve the domestic market and begin drawing export fixed costs for all destinations. Potential firms enter until the cost of entry $W_i f_{e,i}$ equates to their expected lifetime profits:

$$W_i f_e = n_s \mathbb{E}D_i \left[V_{dom,i}' + \sum_{j \neq i} V_{\infty,ij}'\right],$$

where

$$V_{dom,i} = \pi_{ii} + n_s \mathbb{E}D_i' V_{dom,i}',$$

and π_{ii} is the optimal static profits from operating in the domestic region.

2.3 Final Goods Producers

Final goods—including consumption goods C_i, investment goods X_i and material inputs M_i—are produced in each country using domestic and imported intermediate goods. As explained in the exposition of the intermediate goods producers' problem, the iceberg cost, and therefore the price of imported intermediates, depends on the type of final good being produced. Each type of final good $G \in \{C, X, M\}$ is produced by a

continuum of competitive firms. The aggregation technology for final good G is CES

$$G_i = \left[\sum_{j\in\mathcal{I}}\left[\int_{f\in\Omega_{ji}} G_{ji}(f)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}$$

where Ω_{ji} is the set of firms in region j that export to region i, θ is the elasticity of substitution across varieties of a common source region, and $\gamma < \theta$ is the elasticity of substitution across varieties from different source regions.

We represent the problem of final goods producers of good G with a representative firm that chooses inputs to maximize profits

$$\pi_{Gi} = \max P_{Gi}G_i - \sum_{j\in\mathcal{I}}\tau_{ji}\int_{f\in\Omega_{ji}} P_{Gji}(f)G_{ji}(f)df$$

subject to the aggregation technology described above, with P_{Gi} the familiar price index that arises with CES aggregation

$$P_{Gi} = \left[\sum_{j\in\mathcal{I}}(\tau_{ji}P_{Gji})^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \qquad \text{where} \qquad P_{Gji}^{1-\theta} = \int_{f\in\Omega_{ji}} P_{Gji}(f)^{1-\theta}df.$$

Profit-maximizing demand for intermediates from firm f in destination j can be expressed as

$$G_{ji}(f) = \left(\frac{P_{Gji}(f)}{P_{Gji}}\right)^{-\theta}\left(\frac{\tau_{ji}P_{Gji}}{P_{Gi}}\right)^{-\gamma}G_i,$$

which is a constraint for the intermediate goods producers' problem described previously. Tariffs imposed by region i on imports from j (τ_{ji}) in our simulations will be the same for all good types, though the model easily allows for tariffs to differ by good type (Hoang and Mix, 2023).

2.4 Government Budget Constraint and Fiscal Policy

The government collects tax revenue on imports, labor income, and capital income. Tariff revenue from imports TR_i is measured as

$$TR_i = \sum_{G\in\{C,X,M\}}\sum_{j\neq i}\tau_{ji}\int_{f\in\Omega_{ji}} P_{Gji}(f)G_{ji}(f)df$$

We assume that the government balances its budget each period, so the lump sum transfer is equal to the sum over all sources of government revenue less any investment subsidies

$$T_i = \tau_i^L W_i L_i + \tau_i^K(R_iK_i - \delta P_{Ii}K_i + \Pi_i) + TR_i - s_i^I P_{Ii}I_i$$

While it may seem extreme that the government just transfers all revenue back to the household, it allows us to focus on the interaction of alternative fiscal instruments. Likewise, allowing the transfer to vary from period to period rather than explicitly modeling government deficits and surpluses should have a minor impact on our results. In our sensitivity section, we consider cases where the government buys consumption goods using tax revenues, with a constraint that government spending is either constant or is a constant share of nominal GDP. We also solve for a constant tax rate that is consistent with the present value of tariff revenue.[5] Our optimal tariffs and welfare gains under these cases are very similar to the optimal tariff in the model as written.

2.5 Aggregation and Market Clearing

While heterogeneous firm models normally entail a very large state space, two assumptions simplify aggregation, which reduces the state space substantially. First, we assume that production is constant returns to scale with freely adjustable inputs. Second, we assume that fixed export cost draws are independently and identically distributed (iid) across time and destinations for all firms conditional on having the same cost state. As such, export decisions are made independently across destinations. Furthermore, rather than keeping track of the fixed and iceberg costs of the distribution of individual firms, we only need to keep track of the mass of firms in each cost state. Using the cost-state specific export thresholds, one can then derive laws of motion for the number of firms in each state, as detailed in (Mix, 2023).

In equilibrium, the capital and materials markets must clear such that the sum of capital demanded by intermediate producers is equal to the capital stock held by households and the sum of materials demanded by producers is equal to the materials sold by final goods producers. Similarly, the labor market must clear: Labor supplied by households must be equal to the sum of labor demanded for production *and* payment of exporting and entry fixed costs by intermediate goods producers. Finally, bonds are in zero net supply, $\sum_i B_i = 0$.

2.6 Calibration

We calibrate the model to include only two symmetric countries. Given our focus on using tariff revenue for tax relief, this allows us to consider the broadest set of tariffs. We focus on a quarterly model to capture the dynamics of the reform and allow for some consideration of anticipation effects. The macro side of the model is calibrated to be consistent with typical international macro models and models of fiscal policy. The trade side is calibrated to be consistent with several aspects of firm and exporter dynamics and largely follows Mix (2023) and Alessandria and Mix (2021).

We normalize the labor endowment $\bar{L}$ and productivity z in each country to 1. With each period representing one quarter, we set the discount factor $\beta = 0.99$ and the capital depreciation rate $\delta = 0.025$. We set the intertemporal elasticity of substitution $1/\sigma = 1$. All these parameters are common values from

[5] Tax smoothing considerations in the spirit of Barro (1979) are very small here.

the literature. We set the Frisch elasticity to 2 as in Alessandria and Mix (2021) as this calibration is able to capture the cross-sectional effects tariff changes from the GATT rounds. This is between the 3 that Prescott (2004) advocates for based on tax policy changes in the US and Europe and the 1 that is used in House and Shapiro (2006) and Trabandt and Uhlig (2011) in their analyses. In contrast, Ignatenko et al. (2025) set the Frisch elasticity to 0.5.

With the use of materials in production, our model differentiates between gross output and value added in the economy. The materials share in intermediate goods production, α_m, is chosen so that the ratio of gross output to value added is 2, consistent with the US.

We assume the elasticity of substitution between varieties from the same source is $\theta = 6$. This implies a markup of 20 percent and is in line with most macro analysis in monetary models. The elasticity of substitution between different sources is set to $\gamma = 3.75$ and generates a short-run quarterly trade elasticity of 3.75. Together, γ and θ (along with calibrated exporter behavior, discussed below) yield a long-run trade elasticity of about 7.0 to a permanent global change in tariffs.[6] We also use the same shape parameter $v = 0.65$ for the generalized Pareto distribution as calibrated in Mix (2023). The survival rate of intermediate goods producers is set to n_s =0.995 to match the labor share of exiting firms in the data.

There is disagreement on the dynamics of the trade elasticity. Following Head and Mayer (2014) and Simonovska and Waugh (2014), much quantitative work in static trade models targets a trade elasticity of 4 to 5. Recent work by Boehm et al. (2023) finds a 1 year trade elasticity of less than 1 that rises to about 2 after ten years. In contrast, Alessandria et al. (2025a) recover a short-run elasticity of about 3 and long-run elasticity of 14 with about half the gap between short-run and long-run closed every five years for large permanent changes in US trade policy on China and Vietnam. Yi (2003) points out that the relationship between the growth in US imports and fall in tariffs points to a long-run elasticity that is between ten to fifteen. We view our calibration as conservative given these trade elasticity estimates. We do provide sensitivity to our findings.

Similar to House and Shapiro (2006), we use the estimates of marginal tax rates from the Congressional Budget Office (US Congress, CBO 2025) in 2025. Thus, we set the marginal labor tax to 27.2 percent and the marginal capital tax to 14.7 percent. Initial tariffs are set to 4 percent in line with recent tariffs before 2025.[7] Even though some of these taxes are set to sunset, we assume these tax policies are expected to be constant. All told, government revenue (and spending) amounts to 22.3 percent of GDP in our initial steady state, with 18.0 percentage points of the revenue from labor taxes, 3.7 percentage points from capital taxes, and 0.6 percentage points from tariff revenue. All revenue is rebated lump sum. Our initial equilibrium sets investment subsidies $s_i^I = 0$.

We calibrate the model to be consistent with aspects of the US economy from 2019-2024. Other parameters that still need to be calibrated include iceberg costs $\xi_{G\xi ij}$, scale parameters f_{ei}, the probability of

[6]The long-run trade elasticity to a global permanent reform is not constant but depends on the initial and final tariff, although the curvature in the trade elasticity is modest.

[7]This is close to the current tariff given 2011-2015 import weights. In Appendix A we discuss the difference between the constant weight and trade weighted tariffs. The optimal tariffs are largely unaffected by our initial tariffs.

changing shipping cost states $1-\rho_i$, the relative preference for consumption and leisure μ, and the labor share of value added $1-\alpha$. With our two-region symmetric model (so that the parameters are the same for each region), this list includes 11 parameters, 6 of which are iceberg costs. As in Mix (2023), we simplify the iceberg cost structure and impose the assumption that low-cost-state iceberg costs are proportional to high-cost-state iceberg costs $\xi_{GLij} = \zeta\xi_{GHij}$ with $\zeta < 1$. With this simplification, we reduce the parameters related to iceberg costs to 4 and the total parameters to be assigned to 9. We choose the parameters to jointly match the following moments in steady state:

1. Imports-to-GDP ratio = 0.15
2. Capital goods share of imports = 0.2
3. Material goods share of imports = 0.6
4. New exporter share of total exports = 0.05
5. Export share of exporters with five or less years of tenure = 0.4
6. Export participation rate = 0.2
7. Share of exporters that are new = 0.15
8. Frisch elasticity = 2
9. Labor share of value added = 0.66

These moments are consistent with the current structure of the US economy. The import share of 15 percent, for example, roughly matches the US import share in recent years, as does the split of imports between capital, material, and consumption goods. Moments related to the importance of new exporters are approximations of average export churning statistics taken from the World Bank Exporter Dynamics Database, as described by Mix (2023) and Steinberg (2023).

While these parameters are calibrated jointly to match all moments, some parameters are more influenced by one or more moments. The average level of iceberg costs, for example, are largely pinned down by the first three moments: the import share and the composition of imports. The relative costs for high-cost and low-cost exporters, along with the probability of switching to the opposite state, are most related to the share of exports sent by new exporters and how quickly new exporters' exports grow, which is captured by the share of exports made by firms with 5 or less years of tenure. The scale parameters are pinned down by the export participation rate and the share of exporters that are new each year. Preferences for consumption relative to leisure are pinned down by the Frisch elasticity and the capital share of value added pins down the parameter α. We should note that in our model firms pay dividends as returns to their organizational capital (Atkeson and Kehoe, 2005) and rent capital. Given the markup and roundabout production this implies the capital share in production is only 0.18, or about half of typical calibrations of competitive models.

In our baseline exercises, we assume that initial and long run bonds are equal to 0. That is, we assume $\bar{B}_i = 0$ for all countries i both in the initial and terminal stationary equilibria. Of course, this assumption only matters when tariffs are applied unilaterally, as a global trade war among symmetric countries will not affect trade imbalances.

2.7 Fiscal Policies

We consider four uses of the tariff revenue, TR_t, after a policy change. Before the policy change, all tariff revenue is rebated as part of the transfer to households. After the policy change, it can be rebated lump sum, used to reduce labor or capital taxes, or used to subsidize investment directly. The government runs a balanced budget each period, which allows us to calculate the tax offset or subsidy financed by the tariff revenue. As we focus on financing reforms with the current tariff revenue, this leads to some variation in the tax and subsidy rates over time. However, in the sensitivity section we show that choosing a fiscal policy with the same present value as tariff revenue yields nearly identical optimal tariffs for the investment subsidy case. Below, we describe the details for each available policy.

Lump sum rebate: In this case, lump sum transfers to households in transition remain

$$T_i = \tau_i^L W_i L_i + \tau_i^K (R_i K_i - \delta P_{Ii} K_i + \Pi_i) + TR_i - s_i^I P_{Ii} I_i.$$

Any change in tariff revenue changes the lump sum transfer the household receives.

In all other cases, we assume that all tariff revenue, including the tariff revenue at the initial tariff rate, is used in the new fiscal policy. As such, transfers in transition are instead expressed as

$$T_i = \bar{\tau}_i^L W_i L_i + \bar{\tau}_i^K (R_i K_i - \delta P_{Ii} K_i + \Pi_i) - \bar{s}_i^I P_{Ii} I_i$$

where $\bar{\tau}_i^L$, $\bar{\tau}_i^K$, and $\bar{s}_i^I$ represent the labor tax rate, capital tax rate, and investment subsidy rate in the initial equilibrium, respectively. Tariff revenue is still given back to households, but in the form of variation in the effective tax rate on labor τ_i^L or capital τ_i^K or effective subsidies to investment s_i^I, which we define next.

Labor tax cut: In the case of a labor tax reduction, each dollar of tariff revenue is used to offset labor taxes paid by households. We have

$$\tau_{it}^L W_{it} L_{it} = \bar{\tau}_i^L W_{it} L_{it} - TR_{it}.$$

Rearranging, we have the effective labor tax rate as

$$\tau_{it}^L = \bar{\tau}_i^L - \frac{TR_{it}}{W_{it} L_{it}}.$$

If there is no labor tax reduction, the effective labor tax rate remains at $\tau_{it}^L = \bar{\tau}_i^L$ in transition.

Capital tax cut: In the case of a capital tax reduction, the effective capital tax rate is defined as

$$\tau_{it}^K = \bar{\tau}_i^K - \frac{TR_{it}}{(R_{it} K_{it} - \delta P_{Iit} K_{it} + \Pi_{it})}.$$

As with the labor tax, if there is no capital tax reduction, the effective capital tax rate remains at $\tau_{it}^K = \bar{\tau}_i^K$.

Investment subsidy: If revenue goes to increasing the investment subsidy, it is used to offset expenditure on investment dollar for dollar. The effective investment subsidy rate in transition is

$$s_{it}^I = \bar{s}_i^I + \frac{TR_{it}}{P_{Iit}I_{it}}$$

if tariff revenue is used to increase the effective subsidy, or $s_{it}^I = \bar{s}_i^I$ otherwise.

The investment subsidy is worth considering for four reasons. First, capital income in our model arises from both the rental of physical capital and firm profits. An investment subsidy, by contrast, allows us to more easily compare our results to work that is focused on building the physical capital stock. Second, as trade is intensive in capital goods, a tariff will increase the price of investment by more than other goods, and the investment subsidy can offset this effect. Third, it yields the strongest economic response on the transition to the reforms, which may be important in ensuring the reform is sustainable.[8] Fourth, and more importantly, it closely relates to real world policies such as bonus or accelerated depreciation.

3 Welfare, Optimal Tariffs, and Long-run Changes

We now solve for the welfare-maximizing unilateral and global tariff in the spirit of Bickerdike (1907) and Johnson (1953) without distortions and Boadway et al. (1973), Parry (2001), or Lashkaripour (2021) with tax distortions. Specifically, our analysis is based on the transition for a permanent surprise change in tariffs[9], with tariff revenue either rebated lump sum or used to reduce other taxes or to subsidize investment. For each use of revenue, we simulate the full transition to the new stationary equilibrium for a range of potential tariff levels. For each new tariff level, we measure the change in welfare as the additional consumption (η_i) that would leave the agents indifferent between the initial equilibrium allocations (C_i^*, L_i^*) and the path of allocations under the new policies,

$$\frac{u\left(\left(1+\frac{\eta_i}{100}\right)C_i^*, \bar{L}_i - L_i^*\right)}{1-\beta} = \sum_{t=0}^{\infty} \beta^t u\left(C_{it}, \bar{L}_i - L_{it}\right).$$

We define the "optimal tariff" for each use of revenue as the new tariff level for which welfare is highest.

Interestingly, we find that when tariff revenue is rebated lump-sum, the optimal tariff is negative, regardless of whether the foreign country retaliates. In a large trade literature with static and distortion-free

[8] Many papers argue that investment subsidies are preferred to capital tax cuts in stimulating new capital formation. Several analyses show that capital-income tax reductions provide a windfall to owners of existing capital, with modest effects on marginal investment decisions (Summers, 1981; Auerbach and Hassett, 1992; Hassett and Hubbard, 2002). More recent empirical work confirms that targeted investment incentives such as bonus depreciation, expensing, or investment tax credits generate larger increases in investment per dollar of lost revenue (House and Shapiro, 2008; Zwick and Mahon, 2017). Evidence from tax reform episodes further indicates that corporate tax rate cuts mainly raise stock prices without meaningfully affecting capital formation in the short run (Yagan, 2015). Modern quantitative macro models reinforce these conclusions, showing that lowering the user cost of new capital dominates broad capital-income tax cuts in both output and welfare terms, particularly when investment is lumpy or firms are financially constrained (Gourio and Miao, 2010).

[9] We do not consider the optimal path nor time-consistent tariffs. In our working paper you can find how anticipation influences short run dynamics.

models, optimal unilaterally-chosen tariffs are positive, as they induce positive terms of trade effects for the imposing country. In our framework, however, the terms of trade improvement is outweighed by the negative effects of tariffs exacerbating existing distortions. That said, if the government instead uses tariff revenue to offset taxes or subsidize investment, the optimal tariff is higher and, in some cases, can be positive even if the same tariff is chosen cooperatively by both countries. These differences in optimal tariffs imply that welfare calculations based on a lump sum rebate are generally a poor approximation of tariff-revenue-financed fiscal reforms.

We explore the sensitivity of our results to the features that yield distortions: taxes, markups, and roundabout production. We show that the optimal tariff is largely invariant to the source of the inefficiency provided that the government is using tariff revenue to finance an investment subsidy. If, by contrast, the tariff revenue is rebated lump sum to households, the optimal tariff varies widely depending on the distortions in the model. Indeed, in a distortion-free version of our model, optimal unilateral tariffs are positive when rebated lump sum, revealing that the distortions in our model are the key distinction between our results with lump sum rebates and most of the trade literature.

We begin our analysis considering the optimal new tariff level that would be chosen jointly by both countries to maximize welfare. Then we discuss optimal tariffs when the tariff is chosen unilaterally, with no foreign retaliation. We examine the sensitivity of these results to changes in the underlying structure of the model, either by removing distortions, or by removing various aspects of our model that differentiate it from the broader literature. This analysis focuses on welfare outcomes that include the transition and long-run outcomes for other economic aggregates. At the end of this section, we briefly discuss transitions as well.

3.1 Optimal Cooperative Tariffs

We now show that governments may cooperatively choose positive tariffs to fund some fiscal reforms in the presence of distortionary taxes. Figure 1 depicts the effects of a tariff reform where each country permanently changes its tariff in the same way under the four uses of tariff revenue for a range of tariffs. We consider tariffs that range from an import subsidy of 5 percent to a tax of 30 percent. The first panel plots the effect on welfare, measured as the compensating consumption differential. The remaining panels plot the effect of the tariff on several key economic aggregates in the new steady state. We report the optimal tariff and the steady-state utility-maximizing tariff in Table 3.

When tariff revenue is used to finance other changes in policy, there are actually two reforms. First, at the initial tariff level, we remove the lump sum rebate of tariff revenue and instead use the tariff revenue to finance a tax reform, so that the welfare effect is positive at the initial steady state four percent tariff for tariff-financed reforms. Second, as we change tariffs, we further change the tax or subsidy. We find important differences in welfare by tariff and tax policy.

When tariff revenue is rebated lump sum, moving from the current level of four percent tariffs to free trade raises welfare by about 1 percent. As the welfare curve is still sharply downward sloping at zero tariffs,

we also consider negative tariffs (import subsidies) that are financed with lump sum taxes and report the welfare-maximizing tariff in Table 3. We find that an import subsidy of 23 percent financed by lump sum taxes would boost welfare by over 6 percent. Thus, when tariff revenue is rebated lump sum in our model, not only is there no incentive to tax trade, but there is a strong incentive to subsidize it.

The optimal cooperative tariff is highest (2 percent) when tariff revenue is used to subsidize domestic investment in both countries. Given our current tariff rate is only four percent, there is a very small positive effect on welfare from moving to two percent tariffs and almost no effect in going to free trade. However, shifting from rebating the tariff revenue to using it to subsidize investment increases welfare by around 1 percent, even with no change to the tariff rate.

Consider the difference between going to free trade and going to the constrained optimal tariff level of 2 percent under an investment subsidy. The negative effects of a positive tariff at 2 percent are more than offset by the positive effects arising from an increase in the investment subsidy rate from zero percent at the free trade steady state to 3.8 percent, shown in the bottom left panel. Beyond 2 percent, the negative effects of higher tariffs outweigh the positive effects of an increased investment subsidy so that welfare falls.

One reason that the positive effects of tariff-financed investment subsidies are outweighed by the negative effects of higher tariffs beyond 2 percent is because increases in the tariff rate lead to less and less additional tariff revenue. With higher tariffs, imports fall by more, so that the higher tax rate is partially offset by a smaller tax base. Indeed, as shown by the bottom right panel, tariff revenue as a share of GDP in the new steady state is maximized at a tariff of 18 percent. Beyond that level, a higher tariff actually reduces the investment subsidy rate, compounding the negative effects of further increasing tariffs with additional negative effects from decreasing the investment subsidy. Still, our calibration suggests that a cooperative tariff-financed investment subsidy can increase welfare with a tariff of up to 14 percent, with the caveat that this includes using both initial tariff revenue and additional tariff revenue gained from the tariff increase to subsidize investment.

When tariff revenue is used to cut labor taxes, we find the optimal cooperative tariff is close to zero, and that welfare increases for tariffs up to ten percent. One reason that using tariffs to offset labor taxes is less effective than the investment subsidy is that the tariff increases the price of investment which leads to less capital in the long run. An investment subsidy directly offsets the increased price of investment from tariffs. That said, a labor tax cut yields a larger increase in the number of firms in the economy–shown in the right middle panel–because entry costs are denominated in labor.

Using the tariff revenue to cut the tax on capital income results in very modest differences from our lump sum case. This largely reflects that most capital income in our model is a return on past investments in firm creation and market access, not a return on physical capital, especially given the depreciation allowance. Thus cutting the capital income tax, is largely a windfall for owners of firms.[10] Also, the capital tax does not offset the increase in the cost of investment given the tariff on imports and the high use of imports in

[10]Part of this finding relates to how we model the capital tax as being on the corporate sector profits net of entry costs.

investment.

The left middle panel plots the change in utility from the initial steady state to the new steady state. Comparing the welfare curves to the steady state utility curves, we find that the welfare-maximizing tariffs are lower than the steady-state utility-maximizing tariffs when tariff revenue is used to offset labor taxes or subsidize investment. For our investment subsidy case, the optimal tariff of two percent is lower than the tariff that maximizes steady state utility of seven percent. The higher steady-state utility-maximizing tariff arises from the higher stock of firms and capital in the new steady state, which expand the scale of the economy but require substantial investments along the transition.[11] With the labor subsidy there is a similar gap between the welfare and steady state maximizing tariff (-3 percent vs 2 percent).

3.2 Optimal Unilateral Tariffs

We now consider unilateral permanent changes in tariffs. For this case, we set the bond adjustment cost to ensure stationarity in the net foreign asset position. We discuss the sensitivity to endogenizing long-run bonds in Section 3.5.

The literature recognizes that unilateral tariffs not answered with foreign retaliation can have positive effects for the tariff-imposing country. While households pay higher prices for foreign goods, additional tariff revenue can be used to improve welfare, and, as long as the country has some market power in buying foreign goods, the tariff results in a terms of trade gain for the tariff-imposing country. This result has been shown quantitatively in static perfect competition models of trade with tariff revenue rebated lump sum to households. In these cases, the optimal unilateral tariff is usually related to the inverse of the foreign export supply elasticity (Johnson, 1953).

Our framework, by contrast, yields only welfare losses for positive tariffs if the revenue is rebated lump sum to households, even without foreign retaliation. The top left panel of Figure 2 shows the welfare effects of permanently imposing new tariff levels for the tariff-imposing country with no changes in foreign tariffs. When tariffs are rebated to households lump sum, welfare decreases monotonically with higher tariffs over the tariff range shown. Indeed, as with the cooperative tariffs, the optimal policy with lump sum redistribution is a subsidy on imports, albeit a much smaller subsidy of 6 percent. The difference between this result and those of the literature previously cited relates to a number of distortions in our model such as the presence of labor and capital taxes, market power for firms with endogenous inputs, and roundabout production such that tariffs and markups are imposed on final goods more than once. We discuss these differences in more detail in a later section.

Although lump sum redistribution of revenue yields only negative welfare effects for higher tariffs, using revenue from tariffs to enact other fiscal reforms can yield a substantial welfare gain. We find that using all revenue, both revenue from the initial 4 percent tariff and any additional revenue from higher tariffs,

[11] This is consistent with the finding that steady state analyses of dynamic trade models yields poor approximations of welfare (Alessandria and Choi, 2014b; Ravikumar et al., 2019; Alessandria et al., 2021; Mix, 2023).

to subsidize investment yields a maximum welfare gain of 1.6 percent and this occurs with an increase of tariffs to 18 percent. At this tariff level, in the long run, consumption is 3.5 percent above its initial level and employment is 0.2 percent above its initial level. One reason that the optimal unilateral tariff with an investment subsidy is so much higher than in the cooperative case is because of the terms of trade gain afforded to the tariff-imposing country. Tariffs act as a negative demand shock for foreign countries, lowering wages and prices, which partially offsets the tariff for the tariff-imposing country. With the terms of trade gain, imports fall by less with higher tariffs, such that tariff revenue as a share of GDP, shown in the right panel of the third row, increases by far more than with cooperative tariffs. With more tariff revenue, the government can provide larger subsidies to investment, shown in the left panel of the third row.

At this 18 percent tariff, there is a sizable gap in economic outcomes depending on how the revenue is used. With a lump sum rebate of tariff revenue, welfare would drop 0.8 percent and steady state consumption would fall 1.4 percent while steady state employment would be 1.3 percent lower. Labor tax cuts funded by an 18 percent tariff would improve welfare, though by less than using the revenue to subsidize investment. The optimal tariff when revenue is used to offset labor taxes is also slightly lower, at 14 percent. As in the cooperative case, the capital tax offset looks strikingly similar to the lump sum rebate.

Similar to the global tariffs case, focusing on steady state outcomes overstates the optimal tariff. The optimal tariff with an investment subsidy is about 7 percentage points below the tariff that maximizes steady state utility (18 percent vs 25 percent). And steady state utility with the 25 percent tariff would overstate the welfare gain by a factor of 2 (1.5 percent vs 3.5 percent).

3.3 Retaliation

The welfare results from the unilateral and global tariff cases suggest that the incentive of the rest of the world (RoW) to retaliate to a change in the home tariff also depends on the use of the tariff revenue.[12] Figure 3 plots the welfare curves for home and RoW under a unilateral tariff and with symmetric global tariffs. The left panel plots the case where all tariff revenue at home and in the RoW is assumed to be rebated lump sum. The right panel plots the case where revenue finances investment subsidies. For this case, when the tariff is unilateral, we assume the home country finances an investment subsidy with revenue while the foreign country continues to rebate revenue lump sum. For the global tariff, both countries finance an investment subsidy.

With a lump sum rebate, any increase in home tariffs decreases welfare in the RoW monotonically. Furthermore, RoW has no incentive to retaliate with their own lump sum-rebated tariffs, as that further decreases their welfare.

Now consider the home tariff that finances an investment subsidy. Higher unilateral tariffs decrease RoW welfare monotonically as before, though the welfare effects are somewhat weaker, as the investment subsidy in the home country stimulates demand for foreign exports. Unlike lump sum-rebated tariffs, the RoW is

[12] While straightforward, we do not solve for the Nash equilibrium since it depends strongly on the fiscal adjustment.

better off retaliating with identical tariffs, as evidenced by the welfare curve for global tariffs being strictly above the RoW welfare curve for unilateral tariffs.

These results reflect our optimal tariff results from earlier sections. With lump sum-rebated tariffs, the optimal tariff is negative because tariffs exacerbate existing distortions. Even if RoW's trade partner increases their own tariffs, the optimal tariff is still negative, so that increasing tariffs decreases welfare further. With tariff-financed subsidies, however, the optimal tariff is positive. If RoW's trade partner raises tariffs, the RoW can recover some welfare by raising its tariff nearer to the optimal level.

3.4 Efficiency and Optimal Tariffs

We now turn to identifying the sources of the large differences in welfare-maximizing tariffs depending on the use of tariff revenue. A striking feature of the baseline is that with a lump sum rebate, it is optimal to subsidize trade both unilaterally and cooperatively. This outcome is surprising, but it reflects the distortions present in our framework. Beyond distortionary taxes, two features of monopolistic competition generate inefficiencies: first, the familiar markup wedge between price and marginal cost is an issue because we have several variable inputs, and second, the compounding of markups and tariffs through the roundabout production structure. These markups also lead to too little entry (Dixit and Stiglitz, 1977; Bilbiie et al., 2019). To assess the role of these distortions, the left panel of Table 3 reports the welfare-maximizing tariffs under both the lump sum rebate[13] and the investment subsidy as we sequentially remove these distortions or add alternative fiscal instruments. These cases should be viewed with caution since they require increasing lump sum taxes by 70 percent of GDP. The right panel of Table 3 reports the compensating differential in moving to a new tariff and tax regime.

Starting with the unilateral tariff that is rebated lump sum, the baseline yields an optimal tariff of *negative* 6 percent. Eliminating distortionary taxes ($\tau_k = \tau_l = 0$) raises the optimal tariff to zero percent, while introducing a revenue subsidy that offsets the markup raises it further to 17 percent. These are clean examples of the benefits of using domestic policy to fix the distortion (Bhagwati and Ramaswami, 1963). However, with roundabout production and markups, just funding the revenue subsidy requires lump sum taxes of nearly 50 percent of GDP. Still, we find that the sign and magnitude of the optimal tariff with a lump sum rebate are sensitive to the particular distortions and fiscal instruments present in the model.

By contrast, when tariff revenues are used to fund an investment subsidy, the welfare-maximizing unilateral tariff is remarkably stable across specifications, ranging from 16 to 18 percent. This stability highlights that the revenue channel—how tariff receipts are allocated—is central to the welfare consequences of trade policy. Even though the optimal unilateral tariff changes little with the investment subsidy, the welfare gain changes substantially, falling from 1.67 percent to 0.45 percent. Once we have removed the distortions, one would be better off to provide a lump sum rebate of the tariff revenue.

[13] In the lump sum case, tariff revenues (or expenses for the subsidy) are returned (or raised lump sum) directly to households without affecting distortionary taxes.

Turning to the global cooperative tariff, which eliminates terms of trade motives, we again see large variation in the optimal tariff under the lump sum scheme. The baseline implies an import subsidy of 23 percent and a very large welfare gain of 6.22 percent. Removing distortionary taxes reduces this subsidy to 17 percent and lowers the welfare gain to 3.57 percent. Once we have the revenue subsidy in place, the optimal tariff goes to zero and the welfare gain of eliminating tariffs falls to 0.16 percent. In contrast, when tariff revenue finances investment subsidies, the cooperative tariff changes little, going from 2 percent with all distortions to zero percent with no distortions. The finding that the optimal tariff under both revenue uses converges to zero percent is intuitive. In a model with no distortions, cooperatively raising tariffs distorts the relative price of imports, which cannot be welfare improving for both countries. A unilateral tariff, by contrast, can improve the welfare of the imposing country in an efficient model through terms of trade effects, but it is still a beggar-thy-neighbor policy that harms the target country.

The SS Inv. column of Table 3 reports the steady state utility-maximizing unilateral tariffs with investment subsidies and the change in steady state utility. These values are systematically higher than the corresponding welfare-maximizing tariffs, ranging from 25 percent in the baseline to 28 percent with the revenue subsidy. The gap arises because these steady-state calculations ignore the transitional costs incurred as the economy adjusts to the new policy. The steady-state criterion overstates the optimal tariff relative to the full welfare measure that accounts for the entire adjustment path.

Overall, these experiments underscore two lessons. First, the structure of distortions strongly shapes the level and even the sign of the welfare-maximizing tariff when revenues are rebated lump sum. Second, when tariff revenues are instead directed toward productive investment subsidies, the optimal tariff is robustly positive and stable, suggesting that the revenue channel is the dominant driver of welfare results.

3.5 Sensitivity

We now explain how the features in our model influence the optimal tariff and how to relate our findings to other frameworks commonly used in the literature on trade or fiscal policy. For comparison we focus on how the optimal unilateral tariff under the investment subsidy and lump sum rebate depend on our model features but also report the case of the global cooperative tariff. Results for tariffs and welfare are reported in the different panels of Table 3. We find that when tariff revenue is used to fund an investment subsidy, the optimal tariff is largely invariant to most features of the model except the trade elasticity and initial net foreign assets. In contrast, when revenue is rebated lump sum, the optimal tariff varies widely with the structure of the model. Specifically, with a lump sum rebate of tariff revenue, the optimal unilateral tariff varies by 27 percentage points compared to only 4 percentage points with the investment subsidy.

3.5.1 Composition of Trade and Labor Supply

We now consider several features of our model that are not common in trade models related to endogenous labor supply and investment. As we have discussed, eliminating distortionary taxes has almost no impact

on our optimal tariff with the investment subsidy but increases the optimal tariff with the lump sum rebate. Further eliminating the labor supply decision increases the optimal tariff with the lump sum rebate to 9 percent but keeps our investment subsidy optimal tariff at 17 percent. Eliminating the labor supply decision leads to a higher optimal tariff with the lump sum case as we have eliminated the inefficiency from having a markup on goods and not on labor that the import tax is trying to partially correct.

Next, we consider how the composition of trade and nature of production influences our results. First, if we set trade costs to be the same on all goods, our optimal tariff with the investment subsidy rises to 18 percent while with the lump sum rebate it rises to 13 percent. If we next eliminate roundabout production, so there is no compounding of the markup we find the optimal tariff rises to 20 percent if it is used to finance the investment subsidy and 18 percent if it is rebated lump sum. Finally, in our last case we increase the trade cost on inputs used in the production of capital so that all trade is in consumption goods. Now, we find the optimal tariff rises to 22 percent with the investment subsidy and 21 percent with the lump sum rebate. We attribute the increase in tariffs in all of these cases as internalizing the effect of tariffs on inputs to production.

3.5.2 International Financial Markets

We now show that our results are robust to our model of international financial markets.[14] In our benchmark analysis we had a relatively high bond adjustment cost that ensured stationarity. We now consider three cases: 1) no international borrowing and lending, 2) endogenizing the long-run bond position and 3) an initial net foreign asset position to generate an initial US trade trade deficit. The optimal unilateral tariff is unchanged in the first two cases. It varies more with initial net foreign asset position.

In our baseline, using a unilateral tariff to fund an investment subsidy triggers an investment boom that is partly financed with international borrowing that is fully repaid eventually owing to our adjustment costs. Going to financial autarky eliminates borrowing and lending but yields the same optimal tariff of 18 percent. Solving for a new long run bond with a shooting algorithm also yields the same optimal tariff of 18 percent. The welfare gain for the US is increasing with the flexibility we provide on international borrowing and lending, but the optimal tariff is not noticeably different.

In our baseline model, we assume an initial zero bond position and introduce adjustment costs on bonds to maintain the initial bond position in the long run. However this assumption misses out on the persistent US trade deficit. We now adjust the model to allow for an asymmetry in the initial net foreign assets to capture the persistent US trade deficit. Specifically, we assume the US has positive net foreign assets ($B_0 > 0$) to generate a trade deficit of 3 percent annually. We consider the case where the bond is denominated in units of the US consumption bundle or RoW bundle. With initial positive net foreign assets, the optimal unilateral tariff increases to 28 percent when the asset is denominated in US consumption goods and 21 percent when

[14] We do not consider the complete markets case with tariffs. Stockman and Dellas (1986) and Alessandria et al. (2021) show that with complete markets countries will lose from increasing tariffs since they've already traded away the income from tariffs and are only left with higher prices. Caliendo et al. (2025) make this point.

it is denominated in the RoW bundle. The higher tariff largely owes to the larger tax base since the US is importing more than it exports. The large differences based on the denomination of the bond owe to the valuation effect on the bond from the real exchange rate appreciations. When the bond is indexed in US goods the appreciation reinforces the benefits of a tariff while when it is in foreign goods it offsets it.

3.5.3 Government Taxes and Spending

We now show that the optimal tariff to fund an investment subsidy changes very little when we choose a constant investment subsidy or introduce government expenditures into the model.

Constant investment subsidy For simplicity, in each period we use tariff revenue to pay for the current subsidy. Owing to the dynamics of trade, the tax subsidy on investment is not constant, starting out around 20 percent and falling to 17 percent. These changes in the tax subsidy are inconsistent with either tax smoothing principles or the way tax policy is implemented. As such we solve for a constant subsidy rate such that the present value of tariff revenue equals the present value of investment subsidies. Such a structure would involve government saving and partly financing subsidies from these savings. Rather than introducing government bonds, we assume that lump sum transfers are adjusted in the background to fill the gap. Doing so yields essentially the same optimal tariff of 18 percent, but the lower initial investment subsidy yields more of a short boost to the economy and similar long run expansion. The welfare gain is slightly higher (1.68 vs 1.67) while long-run utility is slightly lower (3.59 vs 3.61). We plot the transitions in Figure A3.

Government spending In our baseline model, there is no government spending sp all government revenue is rebated lump sum to households. To explore the role of this abstraction on our results, we change the model so that the government is required to consume a constant fraction of output in final consumption goods. No agent in the model benefits from the purchase of these goods. In our initial steady state, we assume that government spending is equal to 17 percent of nominal GDP, thereby reducing the lump-sum transfer to about 5 percent of GDP. The aggregator for the government good is the same as the consumption aggregator.

We consider cases in which the government spending is a constant fraction of nominal GDP (17 percent) over the transition and when government spending is a constant value taken from the initial steady state over the transition. In both cases, the optimal tariff is little changed when tariff revenue is used to subsidize investment, remaining between 16 and 19 percent in the unilateral case and between 1 and 2 percent in the cooperative case. Specifically, if we force government spending to stay at 17 percent of GDP the optimal tariff falls slightly as some of the benefits for the fiscal reform are wasted. If we hold expenditures constant, we find a slightly larger optimal tariff of 19 percent.

3.5.4 Trade Elasticity and Markup

The trade elasticity has an important influence on the optimal tariff. Likewise, as we have discussed, the markup influences the efficiency of the economy. We now provide some sensitivity of the optimal tariff to both notions.

Trade Elasticity Consistent with prior work we find that lowering the trade elasticity increases the optimal unilateral tariff. This result holds when we are using the tariff revenue to subsidize investment and with a lump sum rebate. It also increases the optimal cooperative global subsidies. With a lower trade elasticity, governments rely more on tariffs for revenue. The larger tariffs imply larger investment subsidies thereby increasing the gap between the steady-state utility-maximizing tariff and the welfare maximizing tariff.

Our first experiment lowers the Armington elasticity to 2.75. This lowers the long run trade elasticity to about 3.75. Consequently, with the investment subsidy the optimal unilateral tariff increases to 33 percent. It also doubles the optimal cooperative tariff to four percent. With a lump sum rebate, the global cooperative import subsidy rises to 28 percent and the unilateral import subsidy decreases to 3 percent.

Our second experiment uses our initial Armington elasticity but eliminates firm entry, exit, and dynamic exporting. All firms export. In this case we keep the Armington elasticity at 3.75 but lose the dynamic adjustment. We call this a static model. Our optimal unilateral tariff rises to 37 percent while the global tariff rises to 6 percent.

Our third experiment lowers the Armington elasticity in the static model to 2.75 which increases the optimal unilateral tariff to 50 percent and the optimal global tariff to 7 percent. There remains a very large gap between the optimal tariff with lump sum rebate versus our investment subsidy reform case.

No Markup Finally, we consider two versions of the static model in which we eliminate the markup charged by firms. We do not recalibrate the model. This makes varieties from the same country perfect substitutes. It is a close approximation of the benchmark IRBC model of Backus et al. (1994). When we keep US and foreign goods as poor substitutes, $\gamma = 2.75$, and use tariffs to fund the investment subsidy, we find the optimal tariff rises to 52 percent with unilateral tariffs and 3 percent with global tariffs.

Importantly, now the optimal unilateral tariff with the lump sum rebate is considerably higher at 42 percent as we have eliminated the markup and so the country does not try to subsidize imports to deal with the markup distortion.

When we increase the elasticity of substitution to 10 so that terms of trade considerations are much weaker, and we are closer to the fiscal policy literature, which often works with one good models, we get a much smaller unilateral tariff of 14 percent and a global cooperative tariff of 3 percent when funding the investment subsidy. We continue to have an import subsidy, albeit of only 1 percent, when tariff revenue are rebated lump sum owing to the distortions from taxes and the high share of capital goods in trade.

3.6 Multiple Reforms

We now show that the incentive to use tariffs to finance a tax reform does not just reflect a suboptimal tax system. Specifically, we allow the government to choose a new tariff and change both the labor tax and the investment subsidy. We find that this reform yields a slightly larger welfare gain than with our single instrument tradeoff, but does not change the optimal tariff. The government chooses to increase the labor tax to finance a slightly larger investment subsidy than in our baseline case.

In this exercise, we allow for two exogenous permanent changes: a change to the tariff level, and a change to the labor tax, from $\bar{\tau}_i^L$ to τ_i^L. The effective investment subsidy is then financed by all tariff revenue and any excess labor tax revenue:

$$s_{it}^I = \bar{s}_i^I + \frac{TR_{it} + (\tau_i^L - \bar{\tau}_i^L)W_{it}L_{it}}{P_{Iit}I_{it}}.$$

For example, if labor taxes increase ($\tau_i^L > \bar{\tau}_i^L$), then $\bar{\tau}_i^L W_{it}L_{it}$ is rebated as a transfer to households while $(\tau_i^L - \bar{\tau}_i^L)W_{it}L_{it} > 0$ finances an increase in the investment subsidy. While new labor taxes and tariff rates are constant throughout the transition, investment subsidy rates will vary in transition in response to changes in imports, wages, or labor, similar to our previous exercises.

The top panel of Figure 4 plots the change in welfare for each new unilateral tariff level where tariff revenue finances an increase in the investment subsidy, a repeat of Figure 2. We also plot the welfare gain from choosing this tariff level *and* the new effective labor tax rate that maximizes welfare for the given tariff rate with tariff revenue and any additional labor tax revenue financing increases in the investment subsidy. The bottom panel plots the effective labor tax rates and new steady state investment subsidy rates with and without allowing the labor tax to change.

Our results indicate that raising labor taxes to finance a larger investment subsidy improves welfare, especially when tariffs are low. If tariffs remain unchanged at 4 percent, for example, the welfare-maximizing effective labor tax rate increases from 27.2 percent to 29.1 percent. This increase finances an increase in the investment subsidy rate of 11.1 percentage points relative to the case where only existing tariff revenue finances the investment subsidy, and yields 0.2 percentage points additional welfare gain. The optimal policy changing tariffs and the labor tax is to raise the tariff to 18 percent and raise the labor tax from to 28.1 percent. This policy yields a long-run investment subsidy rate of 21.5 percent and a welfare gain of 1.7 percent, slightly above our baseline of 1.67 percent.

3.7 Transition

We now discuss the dynamic effects of specific permanent tariff and tax reforms. These cases illustrate the dynamics of adjustment. First, we consider a permanent global trade war under each tax response. We then move to the unilateral increase in tariffs under each tax scenario. Agents have perfect foresight about the permanence of the tariffs, retaliation, and the use of tariff revenue for fiscal adjustment once the tariffs are implemented. To capture some of the anticipatory dynamics we assume agents anticipate tariffs may go up.

Specifically, we start the economy in steady state in 2023Q4 and then change agents expectations so that there is a 50 percent chance of a change in trade policy with an import tariff increase to 18 percent that is permanent and global. We go to this level since it is the best unilateral level with the investment subsidy. Prior to the imposition of the tariffs we assume that agents expect tariff revenue to be rebated lump sum. With the imposition of tariffs, we assume agents understand how the tariff revenue will be used to offset other taxes. We only report the results of the path where tariffs are realized.

Global Tariffs Figure 5 shows the aggregate response of several macroeconomic variables to a 14 percent increase in bilateral tariffs, including the anticipatory period. The charts for most variables show the log point difference from the old steady state. We also include the new tax rate or investment subsidy rate, as well as trade and tariff revenue as a fraction of GDP. We focus on a window from 2024 to 2040, at which point we've almost converged to the new steady state.

The effects of tariffs on trade, exporting, firm creation and tariff revenue are quite similar across all fiscal strategies. The tariffs immediately shift expenditures towards domestic goods. Over time, exporters exit the market and new domestic firms enter, so that there is continued gradual substitution that ultimately increases domestic expenditures by a little over four percentage points.

In all cases, tariff revenue jumps sharply with implementation of the tariffs to about 1.8 percent of GDP, much larger than it has been for at least the past several decades. Very quickly thereafter, however, tariff revenue as a fraction of GDP falls sharply. This decline in revenue reflects ongoing substitution of domestic firms and households away from more expensive imported goods. In the long run, tariff revenue as a fraction of GDP settles around 1.3 percent, about double its initial level. Long-run tariff revenue is highest when it is used to subsidize investment, as this offsets the higher costs of imported capital goods, weakening the degree to which households and firms substitute away from imports. Since trade is capital-intensive, the subsidies induce a smaller effect on trade given the changing composition of final demand. The falling tariff revenue implies that tax or subsidy rates need to be adjusted over time. In the long run, tariff revenue can support a 13 percent investment subsidy, a five percentage point drop in the capital income tax, or a two percentage point drop in the labor income tax.

Among the four uses of tariff revenue considered, a lump sum rebate reduces employment and GDP the most as it does not lessen any of the existing tax distortions. By reducing taxes or subsidizing investment, revenue can be used to reduce distortions in the economy elsewhere or encourage additional investment. Thus, GDP, consumption, investment, and labor, all fall less when tariffs are used to reduce taxes or subsidize investment. That said, the various tax reductions and subsidies all have unique aspects of their affects on the economy.

Reducing capital taxes is quite similar to the lump sum case as it is largely a windfall on savings and the extra incentives to invest do not offset the higher cost of investment goods. Thus, the usual argument for low capital taxes does not extend to our richer trade framework, or at least through the tradeoff we consider.

Subsidizing investment has a strong positive effects on GDP *after* the tariff is implemented before GDP

falls again. This brief boost comes from the relatively high values of tariff revenue in the short run relative to the long run. As tariff revenue falls, there is less revenue available for tax cuts or subsidies, and GDP continues to fall. In the long run, however, entry of new firms boosts domestic capacity, so that we see the overshooting in GDP that is common in these models with dynamics trade adjustment and firm entry. With investment subsidies there is an investment boom that crowds out consumption, which dips sharply on impact. That said, long-run consumption is highest with investment subsidies, as the larger capital stock expands the capacity of the economy. Wages are also higher in the long run with investment subsidies, as the complementarity between capital and labor in production increases the marginal product of labor.

Reducing labor taxes weakens the usual substitution effects arising from a tariff. Tariffs are a tax on goods, so the substitution effect generally entices households to shift toward more leisure. But, when labor taxes fall, workers keep more of their wages, so leisure becomes more costly. Thus, while the labor effect in the lump sum scenario is about neutral on impact, labor jumps almost 5 percent with a labor tax reduction. Again, the effect of the tax reduction is largest on impact when tariff revenue is at its highest, though labor still remains higher in the long run than for any other revenue destination. Subsidizing labor also reduces the cost of firm entry, so that reducing labor taxes yields the highest growth in the number of firms in the economy. Higher labor and a greater number of firms contribute to a stronger long-run GDP response than in the lump sum rebate economy.

Comparing the path of the tariff financed investment subsidy to the labor tax cut, we find quite different paths of the economy. Both lead to sharp temporary increase in employment but with very different effects on GDP and the composition of expenditures. With the labor tax cut, GDP declines gradually owing to the worse allocation of inputs in production, the shift to investing in building more firms, and the decumulation of capital. With the investment subsidy, GDP never falls below its initial level as the investment subsidy spurs capital accumulation that yields an increase in economic activity in the short- and long-run.

US Unilateral Tariffs Figure 6 shows the aggregate response of several macroeconomic variables in the US to a 14 percent increase in US import tariffs with one year of anticipation before the tariffs are applied and with no retaliation from the RoW. As in the previous figure, most variables are shown as the log point difference from steady state, with the exception of the subsidy rates, trade over GDP, and tariff revenue over GDP, which are shown in levels. We also now include the trade balance, shown as its level relative to GDP, and the real exchange rate, shown as the log change from steady state.

With a unilateral change in tariffs there is a larger increase in tariff revenue as the real exchange rate appreciates by about half the change in the tariff. The appreciation reduces the price increase on imports from the tariff, so that imports fall by less. On impact, tariff revenue jumps sharply to almost 2.0 percent of GDP. It falls back a bit over time, but not nearly as much as in the scenario with foreign retaliation. Indeed, even in the long run, tariff revenue remains roughly 1.8 percent of GDP, much higher than it is with the global increase in tariffs. Similar to the trade war, using tariff revenue to reduce taxes on investment yields

larger and more persistent revenue increases, although these differences dissipate over time. This allows for more tax relief in the US economy, with the investment subsidy around 17 percent and a reduction of the capital income tax by about seven percentage points, and a cut in the labor tax by 2.5 percentage points.

The aggregate effects on the US economy for a unilateral tariff are very different than in the trade war scenario. First, there is a smaller increase in employment, largely reflecting a smaller increase in the number of domestic firms. Unilateral tariff hikes are less costly than the trade war for exporters in both countries. In the US, exporters do not face large tariff hikes abroad. In the RoW, exporters do not see the same increase in input costs that they would if the RoW retaliated with similarly high tariffs. As such, the value of exporting falls by less, and the value of being a purely domestic firm—the value of concern for potential entrants—rises by less. With less labor needed for fixed entry costs, labor demand is not as high. The unilateral change in tariffs generally has a less negative effect on other aspects of the US economy than in the trade war scenario. Indeed, with the investment subsidy, GDP grows by almost 4 percent in the long-run. In all cases there is a long-run increase in consumption. Notice, however, that if tariff revenue continues to be rebated lump sum, GDP still falls sharply when tariffs are unilaterally applied.

The dynamics of the trade balance depend on the fiscal instrument used. In anticipation of higher tariffs, there is a large trade deficit of about 1.5 percent of GDP, as firm rush to build up to invest before tariffs make investment more expensive. This anticipatory spike in the trade deficit is in the data, as the real US trade deficit increased from 4.5 percent of quarterly real GDP in the fourth quarter of 2024 to 5.8 percent of real GDP in the first quarter of 2025.[15] Our model attributes this spike in the trade deficit to a belief that at least some of the US tariffs will not be met with foreign retaliation. When the tariff is implemented, the trade balance in our model swings to surplus as imports fall more sharply than exports. After that initial swing, imports fall more slowly when tariff revenue is used for capital or investment subsidies, and the trade surplus quickly moves toward a balance. With labor subsidies or lump sum rebates, by contrast, imports fall at a quicker pace, keeping the trade surplus higher for a couple more years.

Again, the transition paths for the investment subsidy and labor tax cut reforms are quite different from the lump sum or capital tax cases. With the labor and investment subsidy cases, employment rises sharply in the short-run. With the investment subsidy, GDP jumps and continues to rise owing to capital deepening. With the labor tax cut, GDP falls gradually in the early stages of the reform before starting to grow in 2030 as the increase in the stock of domestic firms offsets part of the reduction in the physical capital stock.

Figure 7 depicts the changes in the RoW from the unilateral tariffs under each fiscal scenario. With the implementation of the tariffs, the RoW GDP and consumption fall while employment rises slightly on impact. Although the RoW does not impose additional tariffs on imports from the US, the real exchange rate depreciation still makes imports of US goods more expensive. As such, we still see "reshoring" in the RoW, as shown by the growth in the number of firms. This effect is smallest, and indeed, the total effect on

[15] These changes are more extreme when using monthly data as trade balance widens considerable from November 2024 to April 2025 and trade increases too. See Figure A2.

the RoW economy is smallest, when the US uses tariff revenues to subsidize investment.

3.8 Transitions, Steady State, and Optimality

We now show that there is a systematic bias when using the long run of the model to asses trade reforms and recover the optimal tariff. The bias can be quite large for the optimal tariff, about 50 percent, and even larger for welfare, 130 percent. In the left panel of Figure 8, we plot the steady-state utility-maximizing tariff against the optimal tariff. In the right panel, we plot the steady state consumption equivalent from that steady-state utility-maximizing tariff against the consumption equivalent (including the transition) from the optimal tariff in the right panel. We plot these for all cases listed in Table 3, except those in which we changed the trade elasticity. To summarize the results, we include a linear regression with no constant and report the coefficients in each panel. All results are only for the tariff-financed investment subsidy.

We find the steady-state utility-maximizing tariff is about 50 percent higher than our welfare maximizing tariff across our different sensitivities. When we turn to welfare, we find that welfare based on steady utility maximizing tariff is 2.3 times welfare from our transition. Both results suggest some caution to using the long run to evaluate trade policies.

4 The Dynamic Tariff Laffer Curve

Given the focus on tariff revenue-funded reforms, we now consider several aspects of tariff revenue. Specifically, we study the dynamics of tariff revenue in our permanent reform cases, emphasizing that there is a Dynamic Tariff Laffer Curve such that the tariff that yields the most revenue differs across periods. We also study how the fiscal use of revenue influences the revenue collected as well as how the duration of the reform determines the revenue collected.

We turn to solving for the tariff that maximizes tariff revenue with and without retaliation for the case of the investment subsidy. That is, we solve for the constant tariff that generates the largest present value of tariff revenue flows. We use the household's endogenous discount factor, D_i, to calculate the present value recursively as,

$$TR_{it}^{PV}(\tau_i, \tau_{-i}) = TR_{it}(\tau_i, \tau_{-i}) + D_{it+1} TR_{it+1}^{PV}(\tau_i', \tau_{-i}').$$

We also scale the tariff revenue by initial nominal GDP.

The first row of Figure 9 shows how this measure changes with tariffs ranging from zero percent to 100 percent with global or unilateral tariffs. In the unilateral case, we find that a 40 percent tariff maximizes the present value of tariff revenue, generating revenue equal to 57 percent of initial annual GDP over the discounted future. By contrast, keeping tariffs at their initial value of 4 percent garners a present value tariff revenue of only 15 percent of initial GDP. The revenue-maximizing tariff when the rest of the world retaliates with matching tariffs is much smaller at 19 percent, which generates 33 percent of initial annual GDP in

present value tariff revenue. The revenue-maximizing tariff is larger in the unilateral tariff case as a US real exchange rate appreciation keeps US imports higher than in the case when foreign tariffs also change.

To highlight the dynamics in tariff revenue, we also plot the revenue obtained for each tariff over several horizons. These calculations are shown in the second row of Figure 9. Owing to the dynamics of trade substitution induced by the policy, the tariff that achieves the peak revenue in a period starts out high and falls monotonically. The tariff that maximizes revenue in the first quarter after implementation is 40 percent with global tariffs and 90 percent with a unilateral tariff. The tariffs that maximize revenue in the quarter one year after implementation are much lower, about 30 percent and 67 percent for the global and unilateral cases, respectively. The revenue-maximizing tariff continues to fall over time as the elasticity of imports to the tariff change increases. In the long run, tariff revenue each quarter is maximized at 17 percent and 37 percent tariffs for the global and unilateral cases, respectively. Long-run maximum tariff revenue in both cases is just a bit over half of the maximum revenue on impact.

The third row of Figure 9 reports our calculation for the 10-year revenue obtained from each tariff relative to the baseline case of leaving tariffs unchanged at 4 percent assuming initial nominal GDP of $29.7 trillion—US GDP in 2024. Our estimates for the tariff revenue from a 20 percent increase in tariffs to 24 percent are $2.5 trillion with retaliation and $5.0 trillion without retaliation. Both these estimates are in line with estimates from other budgetary models for the Trump administration's proposed tariff increases. Importantly, this increase in revenue is front loaded because import substitution is lowest in the initial periods after the tariffs. The blue dotted line in each figure shows the estimated tariff revenue if one were to use the trade elasticity on impact to impute future revenue. This estimate is always above the actual model-implied estimate, increasingly so at higher tariff rates as it misses out on the substitution that should take place. The gap can be quite big. For instance the 41 percent increase in tariff would generate only $1.2 trillion in extra revenue with retaliation and dynamic substitution compared to $4.9 trillion using the impact trade response.

The tariff revenue generated depends on the use of the revenue. The final row of Figure 9 plots the present value of revenue for fiscal reforms relative to our baseline reform of an investment subsidy for positive tariffs. We find small differences in revenue between the lump sum, labor tax, and capital tax reforms as the direct effect of the tariff swamps the changes in the economy. The investment subsidy, however, yields more revenue. The extra revenue from the investment subsidy reflects a smaller drop in trade owing to the investment boom and more overall economic growth. The difference can be quite large, as much as 9 (5) percent more at a 26 percent global (unilateral) tariff compared to the lump sum case.

The revenue generated also depends on the persistence of the policy reform as there will be less incentive to reduce investments in export access (Ruhl et al., 2008) when the reform is transitory. To explore this idea, we consider reforms of different durations. Specifically, we assume the reforms are put in place for only T periods and the temporary tariff is the one that maximizes welfare in the investment subsidy case (18 percent). We then compare the revenue from these temporary reforms to the revenue in the same window

for a permanent reform. Figure 10 plots both measures for reforms lasting 20 quarters or longer. We do this for the investment subsidy case and the lump sum rebate for the unilateral and global cases.

Compared to a permanent reform, we find that these temporary reforms can overstate or understate the revenue generated in a common window. In the lump sum case, the revenue from the reform understates the total revenue by 2-5 percent. The gap is largest when the reform is shorter. With the investment subsidy, we find the temporary reform generates more 2.5 to 8 percent more revenue for reforms of 20 quarters. These differences arise because temporary reforms induce different incentives to invest in physical capital and exporter capital as discussed in Ruhl et al. (2008).

5 Final Thoughts

We study the aggregate effects of a change in tariffs when the revenue from those tariffs are used to finance other fiscal reforms. Our model combines key elements from the analysis of fiscal and trade policy, including a realistic composition of trade across different types of goods and firm-level trade frictions that lead to firm and aggregate trade dynamics. We find that the aggregate effects of tariffs depend on the use of tariff revenue and are poorly approximated by analyses based on a lump sum rebate of tariff revenue.

Consistent with a large literature on optimal tariffs, we find that in the absence of foreign retaliation, there can be substantial benefits to raising tariffs, particularly if the revenue is used to offset labor taxes or subsidize investment. Even with retaliation, tariff revenue-funded fiscal reforms can greatly mitigate the costs of raising tariffs. Among all reforms, subsidizing investment generally yields the best welfare outcomes. This finding relates to the nature of trade and the high elasticity of physical capital to the price of investment. Given the high use of imported inputs in investment, the relative price of investment rises in response to tariffs, discouraging capital accumulation even with cuts to the tax on capital income. An investment subsidy directly offsets the increased price of investment, making it more effective than a cut to capital income taxes. Labor tax cuts are also more effective than capital tax cuts at boosting economic activity in our model given the important role of labor in the creation of new products.

We abstract from several key international asymmetries related to net foreign asset positions, capital intensity, and several margins that are likely to influence our quantitative results but can easily be incorporated into our analysis. Preliminary work suggests these margins have small effects. However, we do find the welfare-maximizing tariff may differ. Likewise, we have focused on a broad and simple tariff. Heterogeneity in import tariffs across trading partners will matter for the aggregate effects and individual countries, but we expect the effects of the distribution of tariffs across trading partners on the US to be relatively small. We also abstract from the effects of the tariffs on heterogeneous households, which surely influences support for these policies (Carroll and Hur, 2023), and we see incorporating household heterogeneity in our model as an interesting avenue for future research.

Our goal is to understand the interactions between tariff and tax reforms in a dynamic framework that

captures domestic and international fiscal considerations and trade dynamics. We focus on a limited set of instruments and take no stand on optimal fiscal policy, but the differences we identify between our dynamic trade model and models without exporter dynamics suggest this should be studied. Moreover, our finding that lump sum rebates of tariff revenue always lead to worse outcomes than tariff revenue funded tax reforms suggests existing results on trade policy may need to be revisited. Indeed, we find the optimal tariff is quite stable to the structure of the model when tariff revenue is used for a tax cut. This envelope-type condition does not extend to analysis with lump sum rebate of tariffs. In our framework there are strong reasons to unilaterally subsidize imports if the revenue is rebated lump sum owing to the distortions from markups on goods and not on other elastic inputs in the model.

Finally, we evaluate the changes in current trade and tax policy relative to a world with no future changes in trade or tax policy. Understanding how our results vary with expectations about future trade policy is a fruitful direction of research, and these expectations perhaps can be recovered by studying the dynamics of the economy leading up to this period (Alessandria et al., 2025b; Hoang and Mix, 2023). More generally, our framework can be used to consider tariff dynamics with and without time consistency considerations.

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Figure 1: Global Permanent Tariff (Welfare and Long-run effects by tariffs)

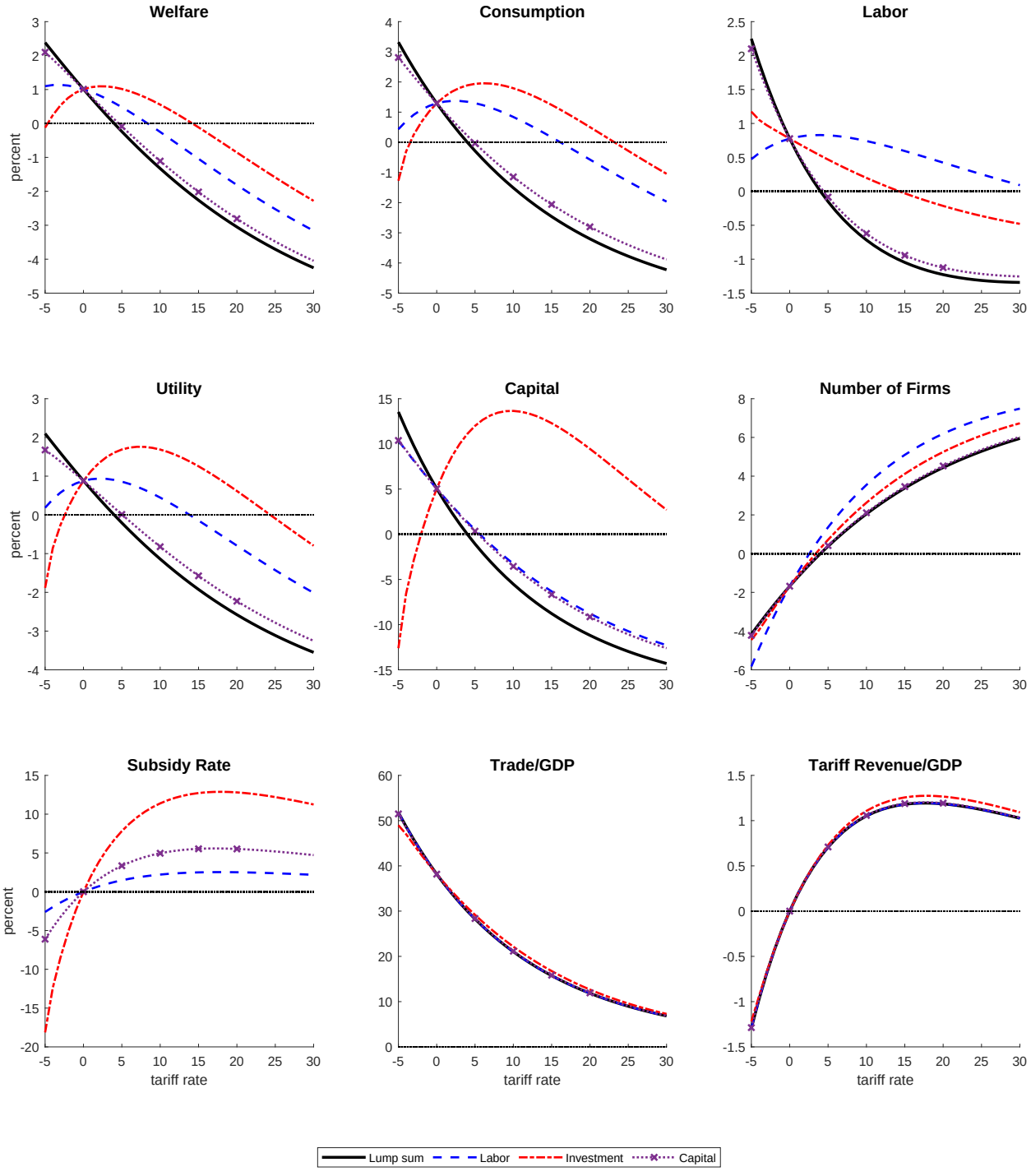


Figure 2: Unilateral Permanent Tariff (Welfare and Long-run effects by tariffs)

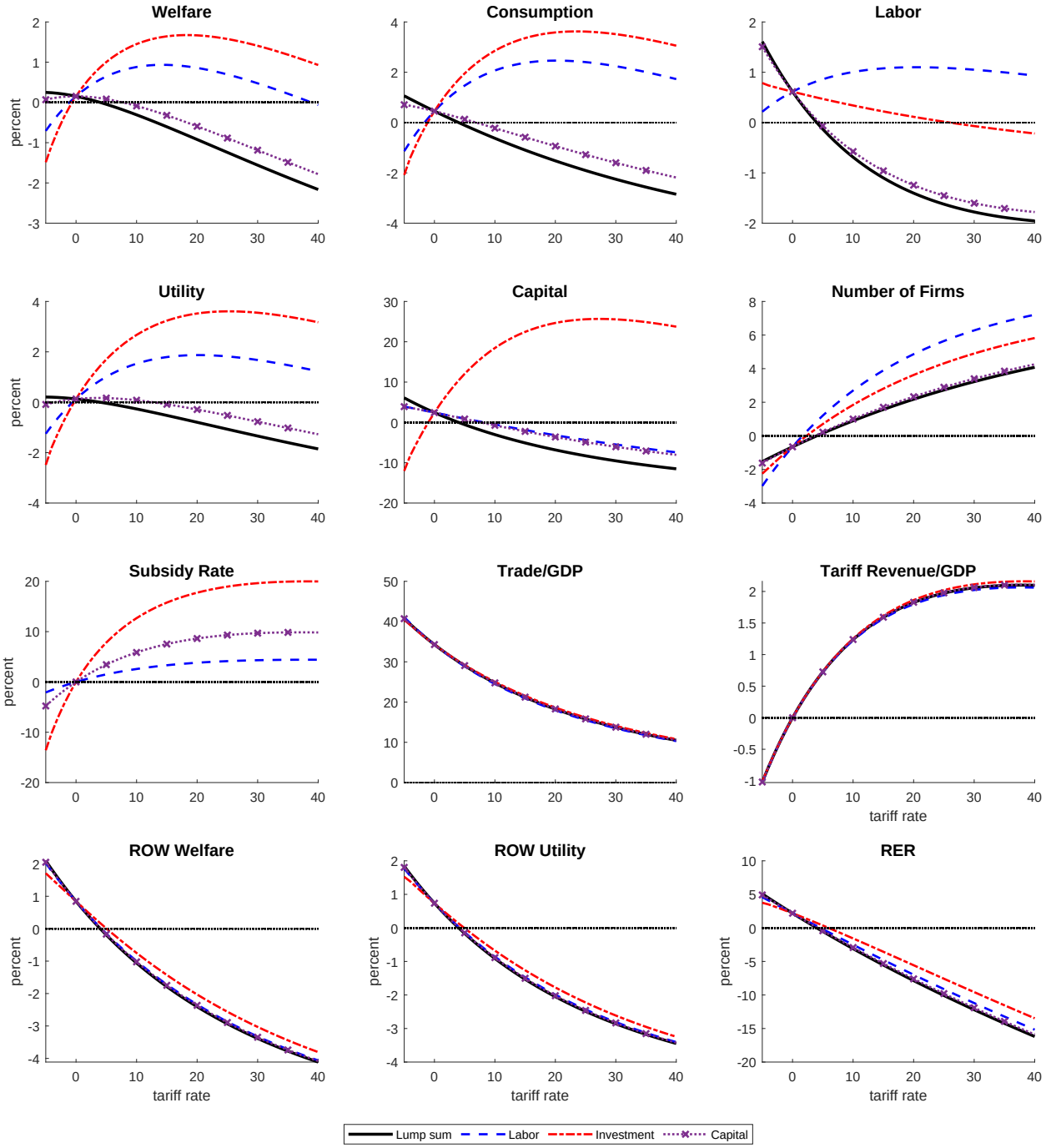


Figure 3: Welfare and Tariffs: Global and Unilateral

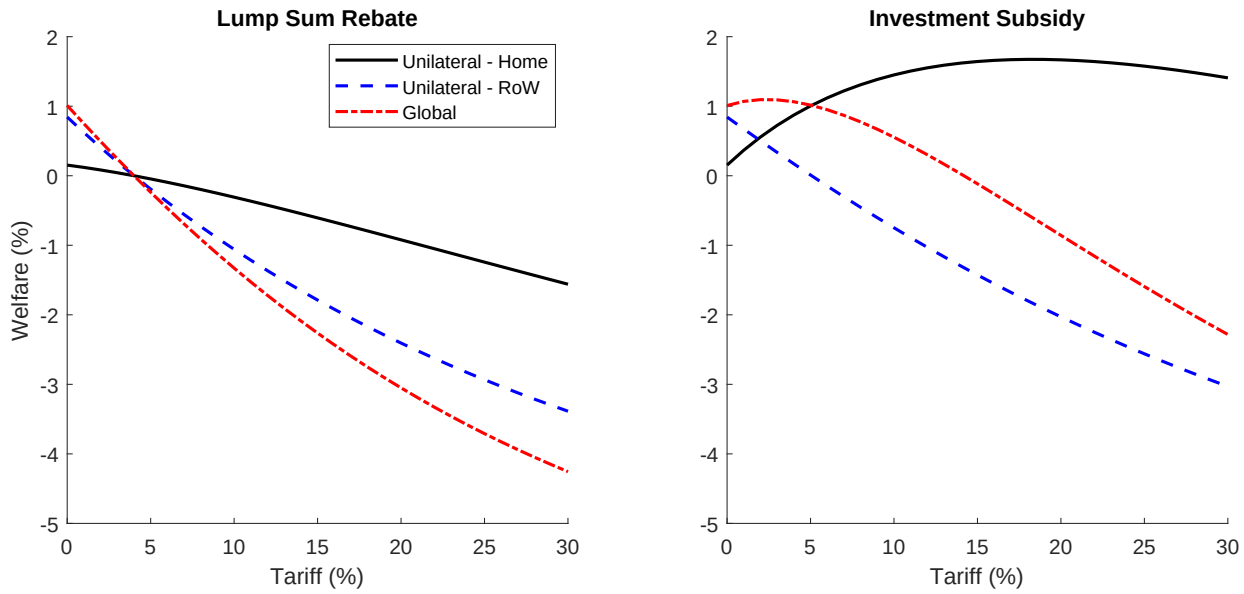


Figure 4: Optimal Tariff (multiple instruments)

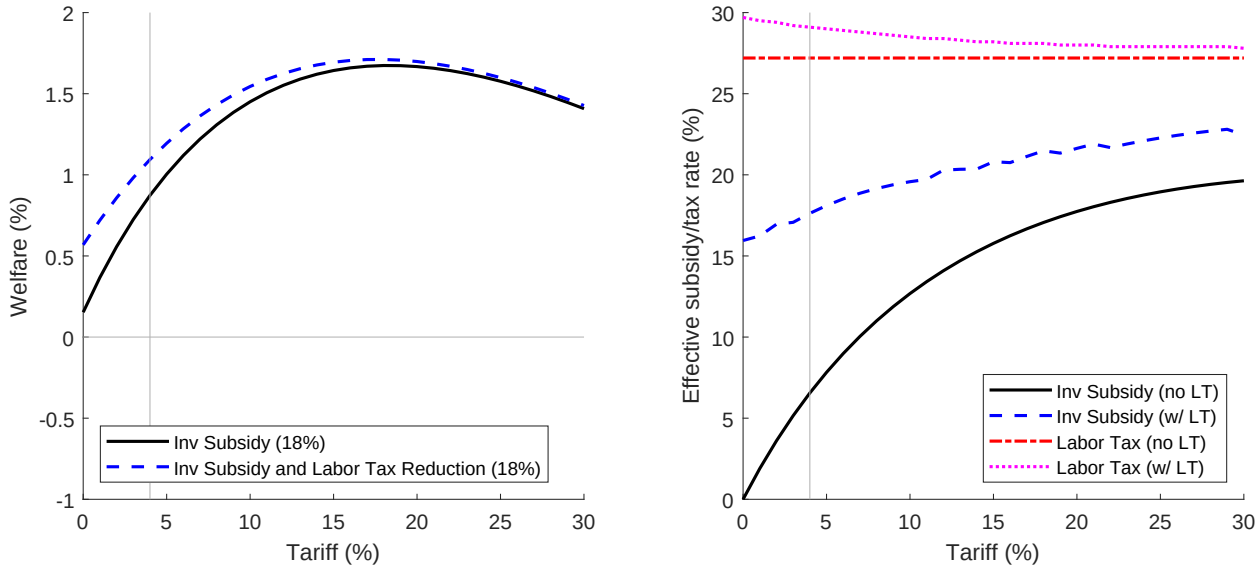


Figure 5: Transition to a 14 percent Global Permanent Tariff Increase by Revenue Use

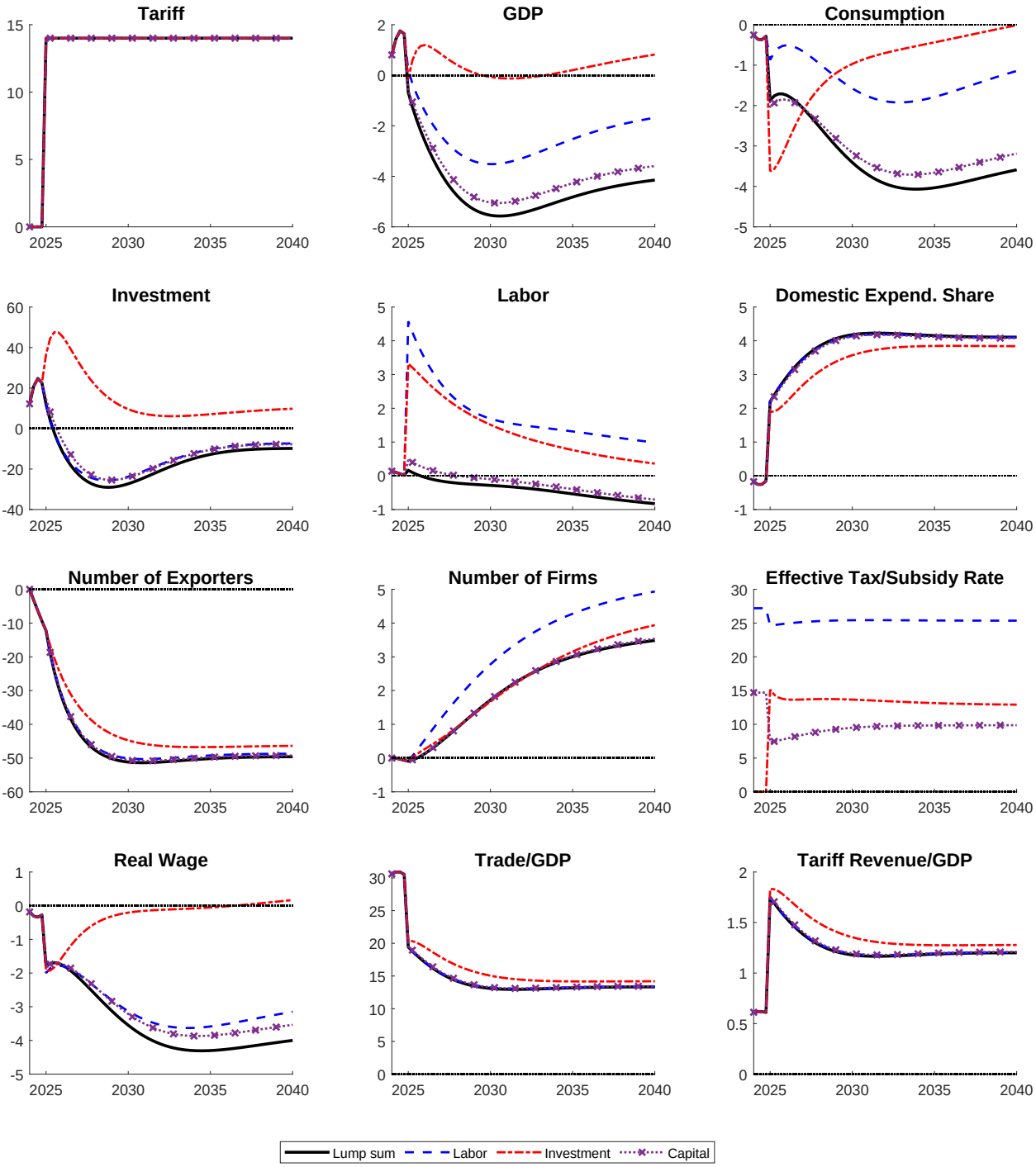


Figure 6: Transition to a 14 percent Unilateral Permanent Tariff Increase by Revenue Use (US)

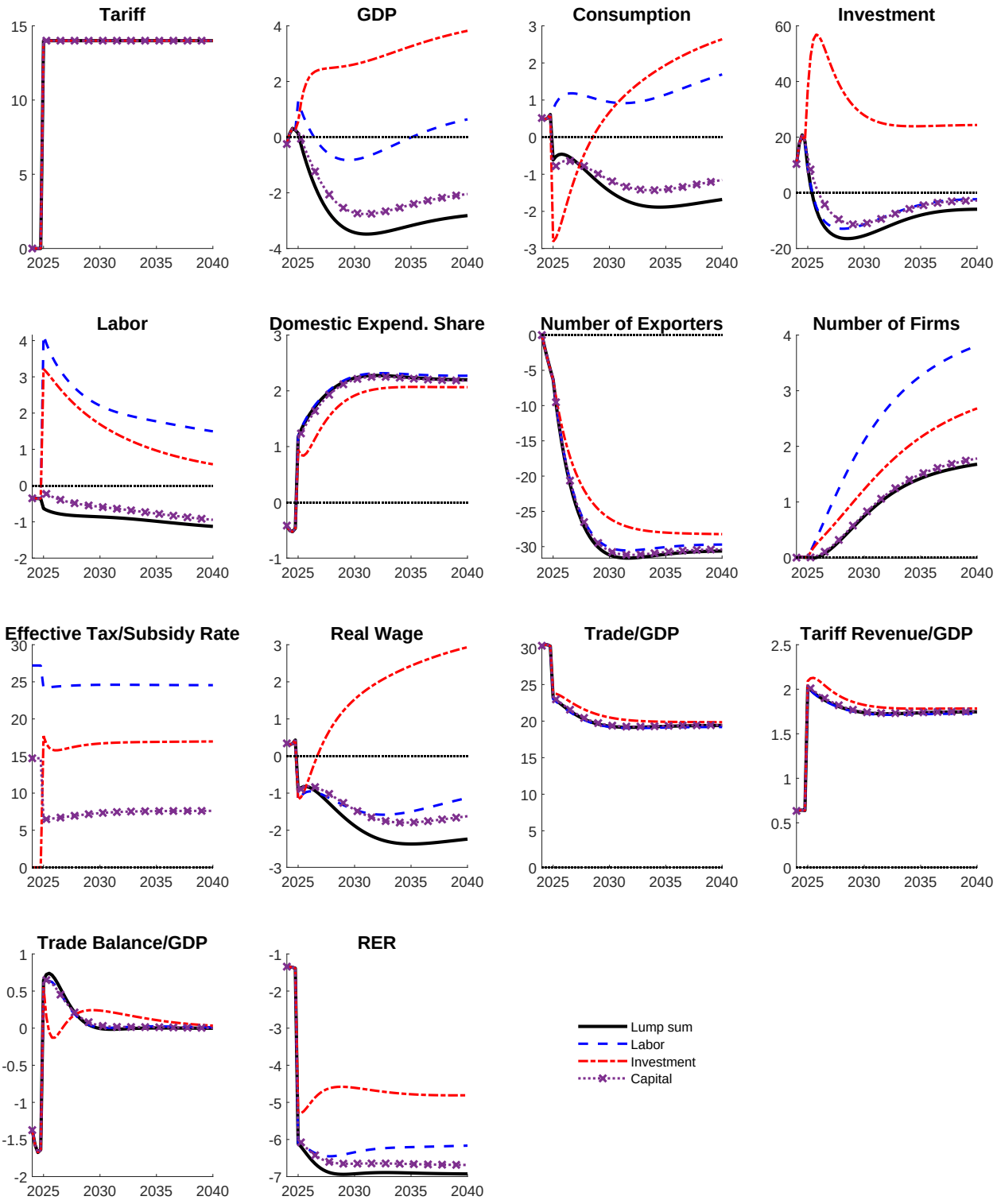


Figure 7: Transition to a 14 percent Unilateral Permanent Tariff Increase by Revenue Use (RoW)

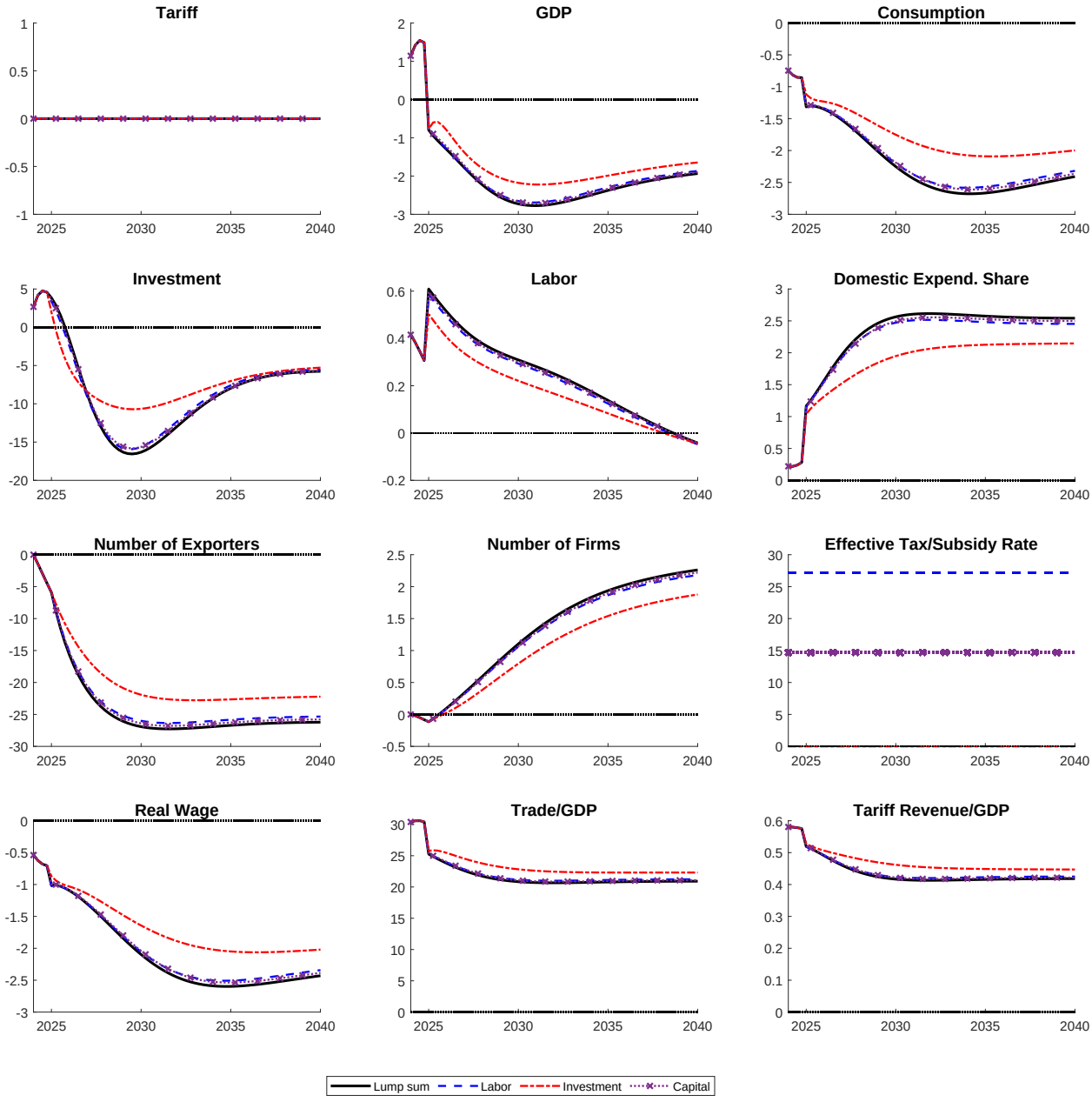
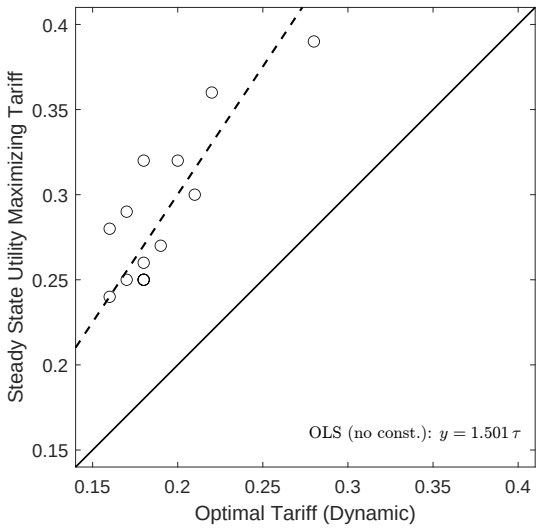


Figure 8: Optimal vs. Long run
Unilateral Policy and Welfare



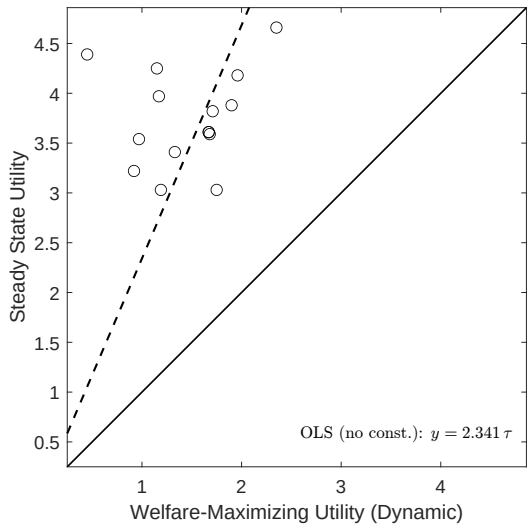


Figure 9: Tariff Laffer Curves

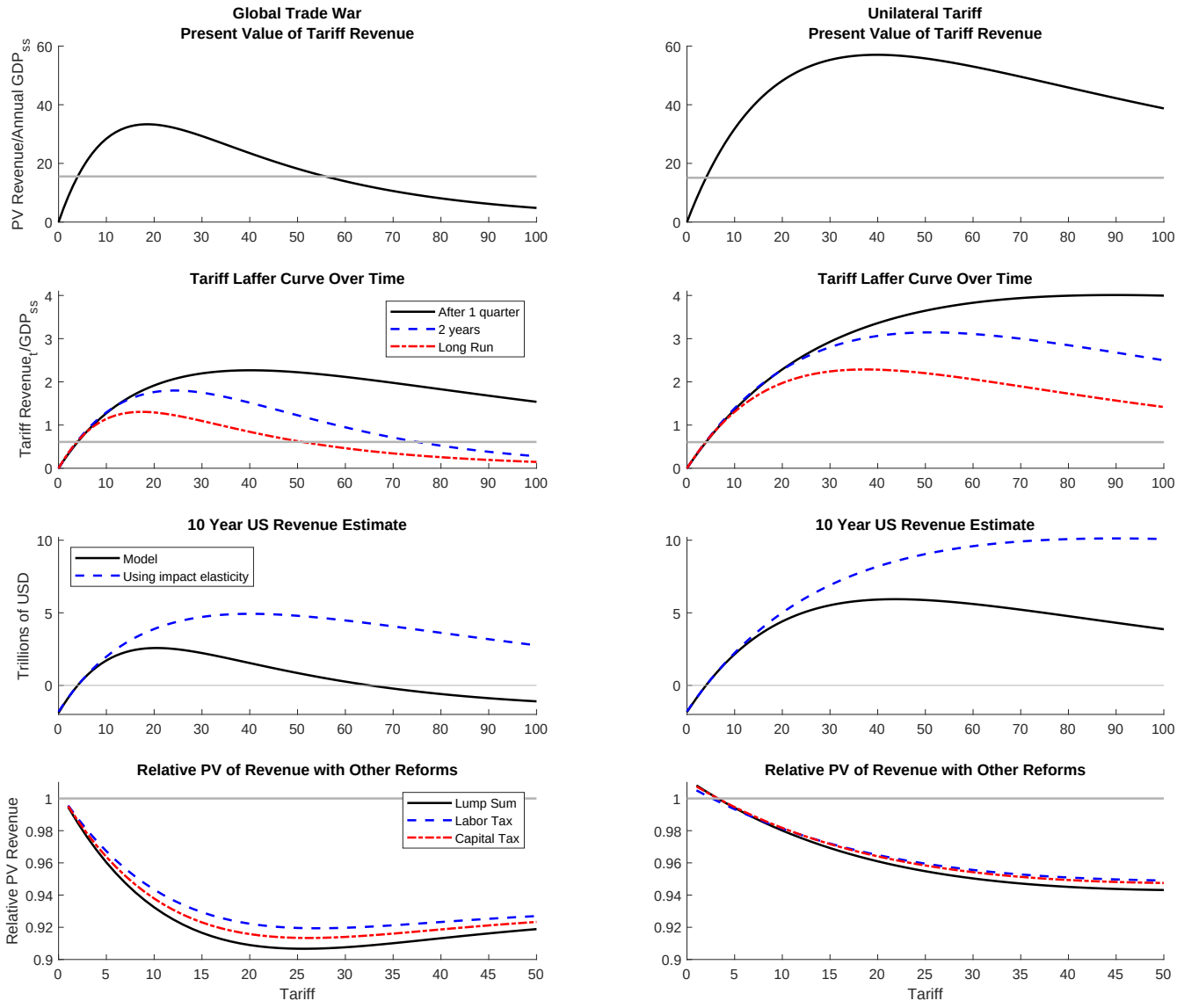


Figure 10: Revenue in common window
Permanent vs Temporary Reforms

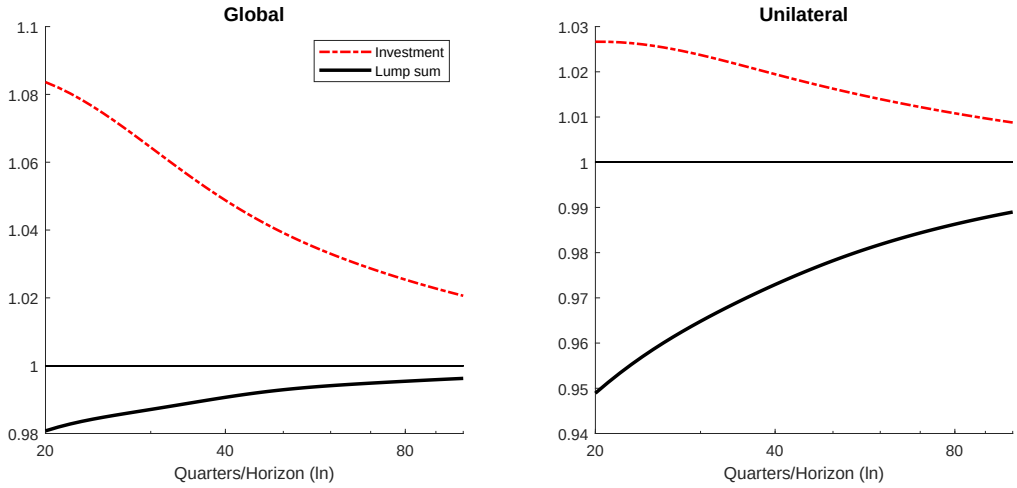


Table 1: Quarterly calibration

Panel A: Externally Calibrated Parameters			
Param	Description	Value	Target
β	discount factor	0.99	
δ	capital depreciation rate	0.025	
σ	CRRA parameter	1	
γ	Armington elasticity	3.75	Quarterly trade elasticity = 3.75
θ	Elasticity of substitution between varieties	6	Markup = 20%
n_s	Firm survival rate	0.995	Surviving labor share
α_m	Share of materials in intermediate production	0.6	Gross output/value added in X & M
α_C	Share of materials in C production	0.99	Gross output/value added in C
$\bar{L}_i$	Labor endowment	1	Normalization
Panel B: Internally Calibrate Parameters			
μ	Relative preference C vs. L	0.49	Average Frisch elasticity=2
f_e	Entry cost	10.26	Average $N_i = \bar{L}_i$
α	Capital share of value added	0.19	Average WL/VA = 66%
f_0	Fixed cost scale (nonexporters)	23.23	Fraction exporters = 0.2
f_1	Fixed cost scale (exporters)	0.030	Incumbent export share = 0.95
ν	Fixed cost shape parameter	0.65	Churning & export volume relationship
ξ_{LH}	Ratio ξ_{GL}/ξ_{GH}	0.58	Export share: firms $\leq$5 years tenure
ξ_{CH}	Consumption-good iceberg cost	3.54	End-use trade flows
ξ_{XH}	Investment-good iceberg cost	1.10	End-use trade flows
ξ_{MH}	Material-good iceberg cost	2.38	End-use trade flows
ρ	Persistency of efficiency state	0.92	Target jointly w/ other parameters
τ_k	Marginal Capital Tax	0.147	OMB (01/25)
τ_l	Marginal Labor Tax	0.272	OMB (01/25)

Table 2: Some Optimal Tariff by Fiscal Reform

		Lump sum	Investment	Labor	Capital
Welfare					
Unilateral	Optimal	-6	18	14	0
	Steady State	-5	25	20	4
Global	Optimal	-23	2	-3	-15
	Steady State	-29	7	2	-11
Revenue					
Unilateral	NPV	39	40	39	39
	Steady State	37	37	37	37
Global	NPV	18	19	19	18
	Steady State	17	17	17	17

Notes: Welfare is based on compensating consumption equivalent that leaves an agent indifferent between the initial steady state consumption forever and either the transition path of consumption and leisure following the change in policy (Optimal) or allocations in the new steady state. Unilateral assumes the other country does not respond. Global is the welfare-maximizing cooperative tariff. Revenue denotes the tariff that generates the maximum revenue based on either the net present value (NPV) or the new steady state for global and unilateral cases by revenue use.

Table 3: Welfare-Maximizing Tariffs and Associated Welfare Gains

	Tariff					**Welfare (% CEV)**				
	Unilateral		SS	Global		Unilateral		SS	Global	
	Inv.	LS	Inv.	Inv.	LS	Inv.	LS	Inv.	Inv.	LS
Baseline	0.18	−0.06	0.25	0.02	−0.23	1.67	0.25	3.61	1.09	6.22
+ No taxes ($\tau_k = \tau_L = 0$)	0.17	0.00	0.25	0.01	−0.17	1.19	0.03	3.03	0.88	3.57
+ Revenue subsidy	0.16	0.17	0.28	0.00	0.00	0.45	0.62	4.39	0.16	0.16
+ Exogenous Labor	0.17	0.09	0.29	0.01	−0.09	0.92	0.07	3.22	0.61	1.36
+ Common trade costs	0.18	0.13	0.32	0.03	−0.05	1.17	0.21	3.97	0.47	0.56
+ No roundabout	0.20	0.18	0.32	0.03	−0.01	0.97	0.48	3.54	0.23	0.16
+ No capital good trade	0.22	0.21	0.36	0.04	0.01	1.15	0.64	4.25	0.20	0.06
Financial autarky	0.18	−0.06	0.25	0.02	−0.23	1.67	0.25	3.61	1.09	6.22
Endogenous LR bond	0.18	−0.06	0.25	0.02	−0.23	1.75	0.27	3.03	1.09	6.22
NFA (bond in US goods)	0.28	−0.04	0.39	0.02	−0.23	2.35	0.13	4.66	1.09	6.16
NFA (bond in RoW goods)	0.21	−0.07	0.30	0.02	−0.23	1.96	0.31	4.18	1.09	6.16
Low SR ($\gamma = 2.75$)	0.33	−0.03	0.46	0.04	−0.28	2.37	0.08	5.16	1.05	6.31
Static ($\gamma = 3.75$)	0.37	0.00	0.43	0.06	−0.25	2.39	0.02	3.69	0.93	4.36
Static no markups ($\gamma = 2.75$)	0.52	0.42	0.66	0.03	−0.11	1.82	1.06	4.31	0.25	0.69
Static high elasticity ($\gamma = 10$)	0.14	−0.01	0.15	0.03	−0.14	1.40	0.07	1.96	0.94	3.23
Constant investment subsidy	0.18		0.26	0.01		1.68		3.59	1.07	
Constant G/Y	0.16		0.24	0.01		1.33		3.41	1.02	
Constant G	0.19		0.27	0.02		1.90		3.88	1.22	
+ Optimal labor tax change	0.18		0.25	0.00		1.71		3.82	1.82	

Notes: Welfare is measured as the compensating consumption equivalent (CEV). Unilateral tariffs assume no foreign response. Global tariffs maximize weighted world welfare. The SS Inv. column reports the welfare equivalent of the steady-state utility change at the steady-state utility-maximizing unilateral tariff.

Appendix (For online publication)

This appendix reports four things. First, we compare alternative measures of tariffs. Second, we consider the recent dynamics of US trade and the trade balance. Third, we summarize our data sources. Fourth, we show the transition with a constant subsidy is quite similar to our baseline with a time varying subsidy.

A Tariff measures

Here we describe the relationship between a time varying trade-weighted measure of tariffs and a constant-weight measure. We use product level tariff data by source from 1974 to 2024. We construct weights based on 2011-2015 country-product import shares. In Figure A1 we compare that to a measure of duties to imports for all US imports and separately for Canada and China. Panel (a) shows the constant weight tariff measure falls from about 10 percent to 1.5 percent before the rise in tariffs in 2018 while the trade-weighted measure falls from 4 percent to 1.5 percent. Thus the tariff measure used in our analysis may only capture 30 percent of the tariff changes.

Most of the gap between the two measures is in the 1970s and early 1980s. Panel (b) shows that for Canada the constant weight measure falls twice as much as the trade-weighted measure. Panel (c), which plots the evolution of tariffs on China, shows that this gap is particularly large as the constant weight measured is roughly two to three times the trade-weighted measure in the 1970s.

B Recent trade and trade balance dynamics

Our theory allows agents to act in advance of a change in trade policy. Here we document two dimensions of these anticipatory effects. In Figure A2 we plot the monthly dynamics of US trade, measured as the average of imports of goods and exports of goods, divided by total business sales, and the goods trade balance, again scaled by total business sales. We focus on a narrow window from 1/23 through 10/25. Two things stand out. First, trade was roughly stable prior to the 2024 election but has since increased by about ten percent and then fallen back. Likewise, the trade balance widened gradually throughout most of 2024, then widened considerably between December of 2024 and March 2025, before falling sharply. The data on exports, imports, and business sales are through October of 2025.

C Data Sources

Most of the analysis is based on the following series that is freely accessible through FRED.

- Real and Nominal GDP (GDPA, GDPCA, GDPQ, BEA)
- Exports of Goods and Services (EXPGSA,EXPGSCA, BEA)

- Imports of Goods and Services (IMPGSA, IMPGSCA, BEA)
- Gross domestic product: Goods: Final sales (A325RC1A027NBEA, BEA)
- Federal government current tax receipts: Customs duties (B235RC1A027NBEA, BEA)
- Federal govt current tax receipts (W006RC1A027NBEA, BEA)
- Total Business Sales (TOTBUSSMSA, Census)
- Exports of Goods, Balance of Payments Basis (BOPGEXP, Census)
- Imports of Goods: Balance of Payments Basis (BOPGIMP, Census)
- Advance US International Trade in Goods: Exports (AITGEXS, Census)
- Advance US International Trade in Goods: Imports (AITGIXS, Census)

D Transitions: Constant Investment Subsidy Case

Here we compare our baseline with a time varying investment subsidy to a case with a constant investment subsidy case in which the subsidy is chosen to be revenue neutral in a net present value sense. Consistent with our findings that the optimal tariff and welfare effects are nearly identical across these cases, we find very minor differences in the transition paths. The constant subsidy rate is slightly more expansionary in the first few years through a stronger investment boom. Owing to the dynamics of investment, the constant subsidy case implies a lower long run investment subsidy than in our baseline case, but the difference is small.

We solve for a constant subsidy rate such that the present value of tariff revenue equals the present value of investment subsidy expenditures, e.g.,

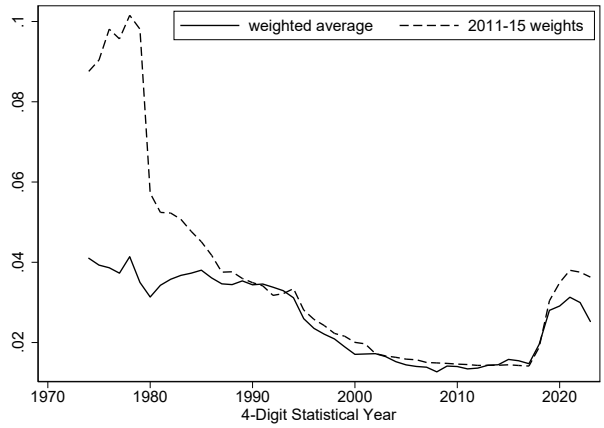
$$s_{it}^I \equiv \bar{s}_i^I = \frac{\sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} M_{s+1} \right) TR_{it}}{\sum_{t=0}^{\infty} \left(\prod_{s=0}^{t-1} M_{s+1} \right) P_{Ii,t} I_{it}},$$

where M_{s+1} is the stochastic discount factor defined as $M_{t+1} = \beta \frac{u'(C_{t+1})}{u'(C_t)}$. This new tax structure involves government saving and partly financing subsidies from these savings. We assume that lump sum transfers are adjusted to fill the gap.

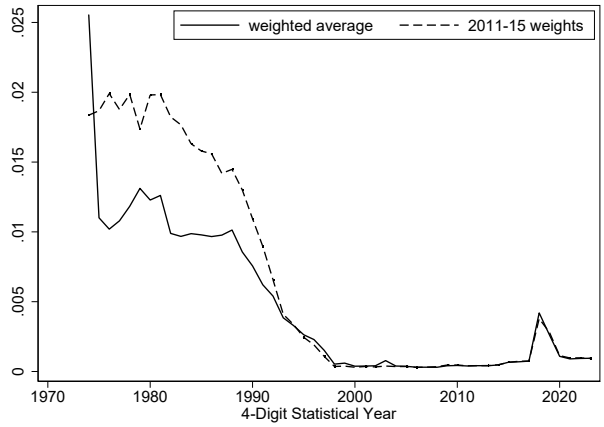
In Figure A3, we plot the transitions for the US economy with a 14 percent unilateral permanent tariff increase with varying or constant investment subsidy. Under these two settings, transitions almost do not differ from each other except the following aspects. First, under constant subsidy rate, the investment response is higher in the initial few years compared to baseline. This occurs because substitution away from imports causes tariff revenue to decline after an initial increase within one year; as a result, the subsidy rate correspondingly falls in the baseline. In contrast, constant high investment subsidy rate ensures investment boom in initial years, accompanied with employment increase, leading to larger output expansion than baseline. Second, trade balance appears larger swings in the constant subsidy case. This may reflect initially high import demand for capital goods driven by a domestic investment boom. As a result, RER appreciation of domestic goods is smaller initially.

Figure A1: Constant and Trade-weighted duties

(a) All Imports



(b) From Canada



(c) From China

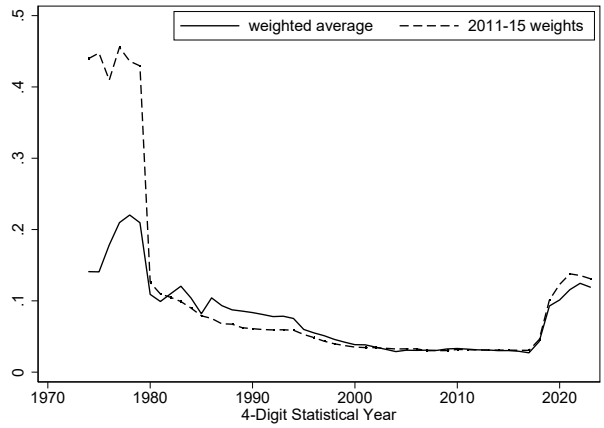


Figure A2: US Trade and Trade Balance: Anticipatory Dynamics

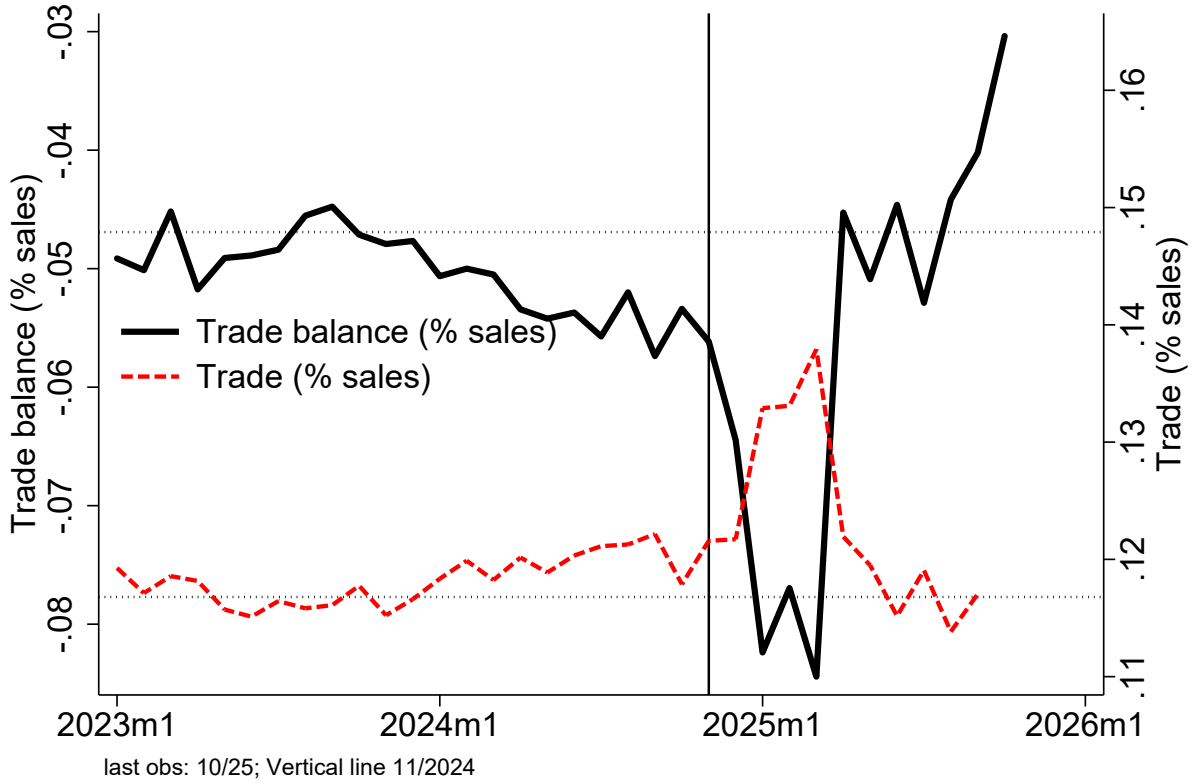


Figure A3: 14 Percent Unilateral Permanent Tariff Increase:
Baseline vs. Constant Investment Subsidy (US)

