Dynamic Optimal Tariffs with Trade Dynamics *

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Abstract

We study how the transition of an economy to a tariff change influences the optimal unilateral tariff. We show the optimal unilateral tariff depends on the dynamics of the trade elasticity when there are firm-level investments in market access. We find that the optimal unilateral tariff is closely related to the mean discounted trade elasticity. We show that models with no dynamics in the trade elasticity approximate the optimal policy when calibrated to target the mean discounted trade elasticity, but that optimal policy provides a poor approximation of the transition path and welfare from the dynamic model. Much like the optimal savings rate in a neoclassical growth model must be adjusted for the adjustment process, so too must the optimal tariff. We show that under full commitment that the optimal tariff path yields higher short-run tariffs and lower long-run tariffs than the one-time change. Without commitment, we find the steady state optimal time consistent tariff is considerably higher than with commitment and closely related to the short-run trade elasticity.

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1. Introduction

This paper contains a re-examination from a dynamic point of view of the familiar problem of a benevolent government unilaterally choosing an optimal tariff. In particular, it is concerned with the interplay between the import tariff chosen by the government and the decisions of firms at home and abroad to make investments in home and foreign market access and to accumulate inputs in the betterment of their investors' welfare. The novelty of our analysis lies in our consideration of the relative fixity of trade in the short-run owing to the past firm-level investments in exporting and production infrastructure and the current and future investments firms can make to bring the economy to a new long-run equilibrium aligned with the government's chosen tariffs.

We focus on how the dynamics of the trade elasticity, which is measured by the change in import expenditures to the change in tariffs, determines the optimal tariff. We show that when the government can commit to a one-time permanent change in tariffs that the optimal tariff depends linearly on the mean discounted trade elasticity where the discounting is with the agent's stochastic discount factor. This is consistent with a large class of multi-country models in which the optimal unilateral tariff is determined by a country's market power, which is closely related to the trade elasticity, country size, and trade barriers (Mill, 1848; Bickerdike, 1906; Johnson, 1953; Gros, 1987; Ossa, 2016). This classic result is often derived in a static model that is described as representing the long-run of a dynamic model (Costinot and Rodríguez-Clare, 2014; Ignatenko et al., 2025). Here we solve for the optimal tariff in an infinite horizon model with an endogenous time varying trade elasticity owing to the market access investments of heterogeneous producers. We show that the optimal unilateral tariff is closely related to what we call the *present-value trade elasticity*, which is the mean discounted trade elasticity following a tariff reform. This object accounts for the growing substitution over time between home and foreign goods in the same way that agents value future periods. We show this object can be quite different than either the short-run or long-run trade elasticity.

In a dynamic model there are several notions of the optimal tariff that differ by one's assumption about the government's policy commitment and target horizon. We focus on the Ramsey problem in which a government chooses tariffs to maximize the discounted sum of welfare of a representative agent in moving from the current equilibrium to the new steady state. We focus on contrasting the unilateral one-time welfare-maximizing change in tariffs with that recovered by maximizing steady state utility in

the new steady state. This latter object is commonly used in policy analysis in dynamic models and is the closest in spirit to the "static as long-run model" consensus. Consistent with work on the golden-rule and modified golden-rule on savings decisions (Phelps, 1961; Cass, 1965; Koopmans, 1963), we find that the optimal one-time tariff change is lower than the tariff that maximizes steady state utility. The gap can be quite large, with the optimal one-time tariff generally about two-thirds of the tariff that maximizes steady state utility.

We also solve for the optimal path of tariffs and find that long-run tariff in that path is about 5 percent lower than the one-time change for our baseline case, but yields very small differences in welfare from the one time welfare maximizing change. We also find that the path of tariffs starts high and then falls quickly as the benevolent government has an incentive to take advantage of the lower short-run trade elasticity, leading to an optimal phaseout of tariffs. The different path of tariffs generates a different path of the economy, particularly the trade balance as the initially high tariffs induce a trade surplus followed by a deficit.

The transition path points to an important credibility problem as governments have incentive to promise lower future tariffs and then not deliver on them when the future arrives.[1] With this in mind, we consider how government credibility shapes the optimal tariff and interacts with trade substitution. We show that when the government can not commit to tariffs, the Markov perfect steady state tariff is about 15 percentage points higher than the long-run steady state tariff with credibility. It also rises slightly more than linearly with the credible tariff. It is much more closely related to the short-run trade elasticity as the government tends to overweight its ability to exploit the relative fixity of trade.

We study the government's choice of an optimal tariff in a variation of the two country general equilibrium heterogeneous firm model with trade dynamics. The model contains the key investment, labor supply, and international lending decisions of the canonical international business cycle model with the heterogeneous firms making dynamic decisions to start and stop exporting. As tariffs are a tax instrument we include a well developed fiscal side that can be disciplined by the data. Following our findings in Alessandria et al. (2025a) that the optimal tariff depends on use of the revenue and that investment subsidies yield the highest welfare, we focus on this use of tariff revenue. We also focus on the choice of the optimal tariff in an efficient variation of our model that eliminates distortions from markups and alternative taxes.

Our paper relates to a large literature on optimal tariffs. Most of this work is done in static models

[1] McLaren (1997) makes a similar point with a two period problem with sunk investments.

(see the review by Caliendo and Parro, 2022) and clarifies the role of various important channels. Our analysis builds on a relatively small literature that studies the microeconomic determinants of trade dynamics that grew out of the work of Baldwin and Krugman (1989); Das et al. (2007) (reviewed by Alessandria et al., 2021a) extended to general equilibrium. Prior work with dynamic models show that the welfare and long-run effects of tariffs depend on the features giving rise to those dynamics.[2] Our paper extends the analysis of the interaction of tariffs and fiscal policy in Alessandria et al. (2025a) by considering how the dynamics of the trade elasticity determine the optimal policy and welfare gains. It is the first paper to explicitly connect the dynamics of the trade elasticity to the optimal tariff. It is also the first paper to solve for the optimal path of tariffs in a model with micro-founded trade dynamics from heterogeneous firms.

The next section describes the model, including the problem of the government. Section 3 discusses our results. Section 4 concludes.

2. Model

We describe an infinite horizon two-country model with heterogeneous firms making dynamic export decisions. Each country is initially identical. We describe the problem of the home country and foreign decisions are similar, but denoted with an asterisk.

2.1. Home Household and Firm Environment

The Home country is populated by a representative household that owns all domestic firms. Time is discrete and indexed by $t = 0, 1, 2, \ldots$. The household supplies labor, accumulates capital, consumes the final good, and receives after-tax firm profits and lump-sum transfers from the government. Initial capital K_{-1} and initial net foreign assets B_0 are given.

Preferences. The household chooses sequences $\{C_t, h_t, I_t, K_t\}_{t\geq 0}$ to maximize expected lifetime utility

$$\max_{\{C_t,h_t,I_t,K_t\}_{t\geq 0}} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \, u(C_t, 1-h_t), \tag{1}$$

[2]For instance, Alessandria and Choi (2014); Alessandria et al. (2021b); Mix (2023) focus on how trade dynamics from firm-level decisions influence the transition to a tariff change while Baldwin (1992); Alessandria and Choi (2014); Ravikumar et al. (2019) study how capital accumulation influences the path of the economy to a tariff change.

where period utility is Cobb–Douglas in consumption and leisure,

$$u(C, 1-h) = \frac{\left(C^{\alpha}(1-h)^{1-\alpha}\right)^{1-\sigma} - 1}{1-\sigma},$$

with $\beta \in (0,1)$ and $\sigma > 0$.

Capital accumulation. Capital evolves according to

$$K_t = (1-\delta_K)K_{t-1} + I_t - \frac{\phi_I}{2}\left(\frac{I_t}{K_{t-1}} - \delta_K\right)^2 K_{t-1}, \qquad K_{-1} \text{ given.} \tag{2}$$

Lifetime budget constraint. Let $\{Q_t\}_{t\geq 0}$ denote date–0 Arrow–Debreu prices for one unit of the Home final good delivered at date t, normalized so that $Q_0 = 1$. The household faces the present-value budget constraint

$$\sum_{t=0}^{\infty} Q_t\Big[(1+\tau_{C,t})C_t + (1+\tau_{I,t})I_t\Big] = B_0 + \sum_{t=0}^{\infty} Q_t\Big[(1-\tau_{L,t})w_t h_t + (1-\tau_{K,t})r_t K_{t-1} + (1-\tau_{\Pi,t})\Pi_t + T_t\Big], \tag{3}$$

where w_t and r_t denote the real wage and rental rate of capital, Π_t are aggregate firm profits net of fixed costs, $\tau_{\cdot,t}$ are proportional taxes, and T_t is a lump-sum transfer.

Firms and profits. A measure N_t of monopolistically competitive domestic firms produce differentiated intermediate goods. A subset $N_{x,t} \leq N_t$ export. Aggregate profits rebated to the household are

$$\Pi_t = \Pi_{d,t}^{op} + \Pi_{x,t}^{op} - w_t\big(f_E N_{E,t} + L_{0,t} + L_{1,t}\big), \tag{4}$$

where $\Pi_{d,t}^{op}$ and $\Pi_{x,t}^{op}$ denote aggregate operating profits from domestic and export sales, $N_{E,t}$ is the mass of new domestic entrants, f_E is the labor cost of domestic entry, and $L_{0,t}$ and $L_{1,t}$ are labor resources devoted to export continuation and export entry fixed costs.

Firm dynamics. The stock of domestic firms evolves according to

$$N_t = (1-\delta_N)N_{t-1} + N_{E,t}, \tag{5}$$

where δ_N is an exogenous firm death rate.

Let $N_{x,t}$ denote the stock of exporters. Surviving exporters draw continuation costs from distribution F_0, while non-exporters and new entrants draw export entry costs from F_1. Let f_t^0 and f_t^1 denote the corresponding export cutoffs. The exporter stock evolves as

$$N_{x,t} = (1-\delta_N)N_{x,t-1}F_0(f_t^0) + \Big[(1-\delta_N)(N_{t-1}-N_{x,t-1}) + N_{E,t}\Big]F_1(f_t^1). \tag{6}$$

Firm values and export decisions. Because firms are owned by the representative household, they discount future payoffs using the household's stochastic discount factor (SDF). Let

$$M_{t,t+1} \equiv \beta\,\frac{u_C(C_{t+1},1-h_{t+1})}{u_C(C_t,1-h_t)}\cdot\frac{1+\tau_{C,t}}{1+\tau_{C,t+1}}, \tag{7}$$

where u_C denotes the marginal utility of consumption. Define $V_{x,t}$ as the value at date t of a surviving firm that enters period t as an exporter (and hence draws export continuation costs from F_0), and $V_{n,t}$ as the value of a surviving firm that enters period t as a non-exporter (and hence draws export entry costs from F_1). Let $\pi_{d,t}$ denote per-firm operating profits from domestic sales and $\pi_{x,t}$ denote per-firm operating profits from export sales (both before fixed export costs). Fixed export costs are paid in labor units f at wage w_t, so their goods cost is $w_t f$.

Let $\Delta_t \equiv V_{x,t} - V_{n,t}$ and define the export surplus

$$S_t \equiv \pi_{x,t} + (1-\delta_N)\,\mathbb{E}_t[M_{t,t+1}\,\Delta_{t+1}]\,. \tag{8}$$

A firm exports in period t if and only if $w_t f \le S_t$. Therefore the continuation and entry cutoffs satisfy

$$f_t^0 = \frac{S_t}{w_t}, \qquad f_t^1 = \frac{S_t}{w_t}. \tag{9}$$

The value functions admit the representations

$$V_{n,t} = \pi_{d,t} + \underbrace{\int_0^{f_t^1}\big(S_t - w_t f\big)\,dF_1(f)}_{\equiv OV_{1,t}} + (1-\delta_N)\,\mathbb{E}_t[M_{t,t+1}\,V_{n,t+1}]\,, \tag{10}$$

$$V_{x,t} = \pi_{d,t} + \underbrace{\int_0^{f_t^0}\big(S_t - w_t f\big)\,dF_0(f)}_{\equiv OV_{0,t}} + (1-\delta_N)\,\mathbb{E}_t[M_{t,t+1}\,V_{n,t+1}]\,. \tag{11}$$

The only difference between $V_{x,t}$ and $V_{n,t}$ arises because exporters and non-exporters draw fixed costs from different distributions.

In our quantitative implementation, we assume exponential fixed-cost distributions. Specifically, for $i \in \{0,1\}$ let $F_i(f) = 1 - \exp(-\lambda_i f)$ for $f \geq 0$, with $\lambda_i > 0$. Then the integrals in (10)–(11) admit closed forms. Define

$$P_{i,t} \equiv F_i(f_t^i) = 1 - e^{-\lambda_i f_t^i}, \qquad \mathcal{M}_i(f) \equiv \int_0^f x \, dF_i(x) = \frac{1 - e^{-\lambda_i f}}{\lambda_i} - f e^{-\lambda_i f}, \tag{12}$$

and let $\mathcal{M}_{i,t} \equiv \mathcal{M}_i(f_t^i)$. The option values can be written as

$$OV_{i,t} = S_t P_{i,t} - w_t \mathcal{M}_{i,t}, \qquad i \in \{0,1\}. \tag{13}$$

Finally, labor resources devoted to export continuation and export entry fixed costs are

$$L_{0,t} = (1 - \delta_N) N_{x,t-1} \, \mathcal{M}_{0,t}, \qquad L_{1,t} = \Big[(1 - \delta_N)(N_{t-1} - N_{x,t-1}) + N_{E,t}\Big] \mathcal{M}_{1,t}. \tag{14}$$

2.2. Tariffs and government

Home levies an ad valorem import tariff τ_t and raises revenue, R_t^{tariff}. That revenue feeds into the government budget constraint along with other taxes to finance government spending and transfers yielding the government budget constraint

$$G_t + T_t = \tau_{L,t} w_t h_t + \tau_{K,t} r_t K_t + \tau_{C,t} C_t + \tau_{I,t} I_t + R_t^{tariff}. \tag{15}$$

Changing tariffs affects tariff revenue and allows us to adjust another tax or transfer. Following Alessandria et al. (2025a) we use the revenue in Home to adjust the tax or subsidy on investment. That is, we hold (τ_C, τ_L, τ_K) fixed and adjust $\tau_{I,t}$ to satisfy (15) each period.

2.3. Production and trade structure

There are two countries Home (policy setter) and Foreign. In each country there is a final good produced with K_t, h_t, and an intermediate composite that includes imported varieties. Imported composite is CES over differentiated foreign varieties with elasticity σ.

Imported-variety index (schematic):

$$X_{F,t} = \left(\int_{\omega \in \Omega_t} x_{F,t}(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega \right)^{\frac{\sigma}{\sigma-1}}, \qquad |\Omega_t| = N_t, \tag{16}$$

so variety/participation N_t is a slow-moving state.

2.4. Calibration

The model is calibrated to two symmetric countries. 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. Each period is one quarter, we set the discount factor $\beta = 0.99$ and the capital depreciation rate $\delta = 0.025$. The intertemporal elasticity of substitution $1/\sigma = 1$. The Frisch elasticity is set to 2.

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.[3] 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. (2025b) 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

[3]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.

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.[4] 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 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
10. Government spending = 20 percent of GDP

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

[4]This is close to the current tariff given 2011-2015 import weights. The optimal tariffs are largely unaffected by our initial tariffs.

are approximations of average export churning statistics taken from the World Bank Exporter Dynamics Database, as described by Mix (2023) and Steinberg (2023).

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. The adjustment costs and solution window are such that the net foreign asset returns to steady state by the end of the transition we consider.[5]

3. Results

First, we define three types of tariff reforms commonly considered. Second, we move on to comparing the effects of these reforms on the economy. Third, we relate our results to the trade elasticity. Fourth we discuss some sensitivity of our results to the model structure.

3.1. Tariff Policy

Our dynamic model allows us to consider the effect of alternative tariff changes. We focus on the following three cases:

1. **One-time permanent tariff reform:** Define a one-time policy: set $\tau_t = \tau^{OT}$ for all $t \geq 0$ with no further adjustment.

$$\tau^{OT} = \arg\max_{\tau} \ \mathbb{E}_0 \sum_{t \geq 0} \beta^t u(C_t(\tau), 1 - h_t(\tau))$$

2. **Steady-state optimal tariff:** We compute the stationary optimal tariff τ^{SS} the constant tariff that maximizes stationary utility subject to stationary equilibrium.

$$\tau^{SS} = \arg\max_{\tau} \ u(C_\infty(\tau), 1 - h_\infty(\tau))$$

3. **Optimal Path:** The Government chooses $\{\tau_t\}_{t \geq 0}$ to maximize household welfare subject to equilibrium and fiscal rules:

$$\max_{\{\tau_t\}} \mathbb{E}_0 \sum_{t \geq 0} \beta^t u(C_t, 1 - h_t).$$

In each case, we solve for the transition of the economy and compute the compensating variation. As discussed, we assume that all tariff revenue is used to change the tax on investment.

[5] Solving for a new steady state bond position without adjustment costs has very small effects on our welfare calculations but substantially increases computational time.

3.2. The optimal tariff

We start by reporting outcomes for the three tariffs considered (Table 2). The optimal one time tariff is about 19.15 percent, while the tariff that maximizes SS utility is 25 percent. The mean discounted expected tariff is 19.35 percent and the long-run tariff is 18 percent.

The transition path of the optimal tariff is plotted in Figure 4 as percentage deviations from the one time tariff change against a log scale of time (to help see the first few years). The optimal path starts with a tariff that is about 7.5 percentage points above the one-time change, but falls nearly linearly to the one-time change in the next five years, before falling another 1 percentage point below the one time change. Unlike the conventional view since Mussa (1978), there is an optimal phaseout of tariffs as the home country seeks to exploit its market power more aggressively upfront.

The difference in optimal long-run tariff across these cases reflect the object being maximized and the instrument being used.

We now turn to the effects of these policies on welfare and the long-run state of the economy, based on a compensating differential. Our one-time policy yields a welfare gain of about 1.67 percent and a long-run increase in steady state utility of 3.46 percent. In contrast, the steady state maximizing tariff yields a smaller welfare gain of 1.56 and a larger gain in steady state utility of 3.56 percent. The optimal path of tariffs yields a small increase in welfare of about 0.01 percent and it leads to slightly lower long run utility of 3.40 percent. That steady state utility is higher than welfare primarily reflects the high capital intensity of traded goods.

The transition of the Home economy over the first forty years is plotted in Figure 5. In all cases, consumption falls before rising by almost four percent in the long-run. Employment rises and then gradually declines but ends higher than it starts. There is a substantial increase in physical capital and the stock of firms. Relative to the one time tariff change, the path of tariffs induces a slightly larger cut in consumption initially and a trade surplus when tariffs are relatively high. This contrasts with a trade deficit with the one-time tariff change as the country runs a deficit on impact to help support the substantial investment taking place.

3.3. What trade elasticity matters?

We now discuss how the dynamics of the trade elasticity influence the optimal tariff and the welfare gain from trade. Specifically, we vary the Armington elasticity, γ, and solve for the optimal one time change

in tariff. Recall that the Armington elasticity in this model also is the short-run trade elasticity. The long-run trade elasticity is determined by the entry and exit decisions of firms.

Figure 1 plots the ratio of the long-run trade elasticity to the short-run trade elasticity against the Armington elasticity $\gamma \in \{2.75, 5.5\}$. This ratio starts out a little below 2 and rises to about 11. Thus, our long-run trade elasticity grows from five to almost sixty as we vary this parameter.

We also plot the discounted mean trade elasticity, what we call the present value trade elasticity. It is defined as

$$\theta_t^{PV} = (1-\beta)^{-1}\mathbb{E}_t\left[\sum_{s=t+1}^{\infty} M_t\theta_s\right]. \tag{17}$$

This notion of the trade elasticity weights the expansion in trade at each horizon by the way the agents value utility at that horizon, characterized by the stochastic discount factor M_t. Owing to the features of the model, it is similar to the long-run trade elasticity for low Armington elasticities. It also rises, but not as quickly as the long-run trade elasticity. For a short-run elasticity of 5.5 we find the long-run trade elasticity is 11 times the short-run trade elasticity while the present-value trade elasticity is only 8 times the short-run trade elasticity. The reason the present value trade elasticity rises less quickly with the Armington elasticity relates to the transition taking longer and so the long-run elasticity is weighted less in the calculation of the PV trade elasticity.

An important question is: How is the optimal tariff related to the trade elasticity? This object is a central object in the derivation of the optimal tariff across a large class of models. In a static model of monopolistic competition, Gros (1987) shows the inverse of this elasticity yields the optimal tariff for a small country. Obviously, as country size changes there are well-known additional considerations, however it is clear that those considerations have a minor impact on the elasticity of the optimal tariff to the trade elasticity. We too find that there is a strong connection with the trade elasticity for our model, but that it is the present value trade elasticity that matters as this captures an appropriately weighted measure of a country's market power over its trading partners over time.

In Figure 2 we explore the relationship between the one-time unilateral optimal tariff and different notions of the trade elasticity. We find that the inverse of the present-value trade elasticity provides a good approximation of the optimal tariff. For low trade elasticities, the optimal tariff is a little higher than that predicted by the inverse trade elasticity, while for very high trade elasticities it is a little below.

We also consider the relationship between the optimal one-time tariff and the short-run trade elasticity

(the triangles). Here we see that there is a very large difference with the optimal tariff considerably below the prediction using the short-run trade elasticity. At one extreme we find the short run elasticity suggests an optimal tariff of 17 percent when it is less than one percent and at the other extreme it predicts an optimal tariff of 35 percent when it is only 26 percent.

We also compute the relationship between the steady state maximizing tariff and the inverse trade elasticity. We find that the steady state maximizing tariff is considerably higher than the inverse trade elasticity. These differences are related to the structure of the economy changing quite substantially over time and involving important costs that must be traded off against the long-run benefits.

3.4. One elasticity model

We next study how turning off the features that yield trade dynamics influence the optimal tariff that we recover. Specifically, we shut off export entry and exit. In this model, the Armington elasticity determines the trade elasticity. We also make trade unbiased.

Figure 3 plots the optimal tariff in the static model against its trade elasticity along with our baseline version of the dynamic model and the dynamic model with unbiased trade. We find that the optimal tariff with unbiased trade is closely related to the trade elasticity, although it exceeds the inverse trade elasticity as we increase it. When we turn to the one elasticity model we find that the optimal tariff is below that from the dynamic model. For high elasticities, the gap is quite small but it grows sharply as the inverse of the present value elasticity rises.

3.5. Sensitivity: Transition path of tariffs

Here we discuss how the optimal tariff path changes with some of the features in the model.

We also study the path for the efficient economy. To return to an efficient economy, we follow Alessandria et al. (2025a) by introducing a sales subsidy to offset the distortions introduced by the markup and removing all taxes. The one-time change in tariff is very similar to our baseline economy, but the path of tariffs is quite different as the government raises tariffs initially by more and drops them more sharply, ending up with a lower long-run tariff.

When we eliminate the trade dynamics, but retain physical capital investment, we find the optimal tariff changes very little along the transition path.

3.6. Time Consistent Tariff

We now shift our analysis to consider a government that lacks commitment on trade policy. As in Kydland and Prescott (1977) and Barro and Gordon (1983), a policy is time consistent if it is optimal to implement in every period given that future governments will re-optimize. The resulting equilibrium is Markov: the government takes future policy rules as given and therefore does not internalize how current actions influence future policy choices. In trade environments, this constraint is quantitatively important. Staiger and Tabellini (1987) and McLaren (1997) show that lack of commitment limits the government's ability to manipulate intertemporal distortions (e.g., entry or investment), leading time-consistent tariffs to differ systematically from their Ramsey counterparts. In our framework, we show a similar result with the time consistent tariff more closely related to the short-run trade elasticity than the long-run trade elasticity.

Government Problem. The economy is summarized by a vector of state variables $s \in \mathcal{S}$, which includes the endogenous objects that evolve over time (e.g. firms, exporters, and capital in each country plus net foreign assets). Given a tariff τ and state s, a competitive equilibrium determines per-period utility $U(s, \tau)$ and a law of motion

$$s' = \Gamma(s, \tau).$$

The government chooses tariffs to maximize the present discounted value of utility,

$$\sum_{t=0}^{\infty} \beta^t U(s_t, \tau_t),$$

subject to the equilibrium mapping $s_{t+1} = \Gamma(s_t, \tau_t)$ and the constraint that policy must be time consistent. As a result, the problem is recursive and the relevant solution concept is a Markov equilibrium in which the tariff is a function of the current state, $\tau = T(s)$.

Time-Consistent Steady State. We restrict attention to stationary Markov equilibria and characterize only the associated steady state. A time-consistent steady state is a pair $(\bar{s}, \bar{\tau})$ and value function V such that

$$V(\bar{s}) = U(\bar{s}, \bar{\tau}) + \beta V(\bar{s}), \quad \bar{s} = \Gamma(\bar{s}, \bar{\tau}),$$

and

$$\bar{\tau} \in \arg\max_{\tau} \left\{ U(\bar{s}, \tau) + \beta V\big(\Gamma(\bar{s}, \tau)\big) \right\}.$$

If the solution is interior, $\bar{\tau}$ satisfies

$$\frac{\partial U(\bar{s}, \tau)}{\partial \tau} + \beta V_s(\bar{s}) \cdot \frac{\partial \Gamma(\bar{s}, \tau)}{\partial \tau} = 0.$$

This formulation imposes time consistency at the steady state while abstracting from the full policy function $T(s)$ and transition dynamics.[6]

In Figure 6 we plot the time consistent tariff in our model for a range of different short-run trade elasticities represented as the inverse of the short-run trade elasticity, γ-1. The time consistent tariff is a bit below this value but rises slightly less than linearly with it.

The time consistency problem is evident from the credible transition path as the government has an incentive to raise tariffs in the short-run more than the long-run. This tariff path yields a trade surplus followed by a trade deficit. As we noted, in financial autarky we get less overshooting of the tariff. With this in mind, we also plot the time consistent tariff when we shut down international borrowing and lending (financial autarky). Removing the option to borrow and save in international markets alters the time consistent tariff a bit. Relative to our baseline, financial autarky lowers the optimal tariff when the trade elasticity is low and raises it when it is low.

In Figure 7 we plot the time consistent tariff against the credible one-time tariff change along with a regression line and its coefficient. There is a very tight linear relationship in this space. The time consistent tariff is about 15 percentage points higher and grows 12 percent faster than the one-time tariff.

4. Conclusion

We show that in a dynamic world a benevolent government needs to consider the pattern of trade substitution over time induced by a path of tariffs to choose the optimal path of tariffs. In this spirit, we solve for the optimal unilateral tariff that maximizes the welfare of a representative agent in an infinite horizon heterogeneous firm model in which trade adjusts gradually owing to forward looking firm level creation and export participation decisions and tariffs are recycled through the government budget constraint to subsidize investment. We show that the optimal tariff is closely related to the mean

[6] We solve for the time consistent tariff by searching for the tariff that the government would not want to deviate from for one period.

discounted trade elasticity and this object can be quite different than either the short-run or long-run trade elasticity, depending on how agents discount the future. This result extends the well-known Mill-Bickerdike-Johnson result to a modern dynamic quantitative trade model. Research should focus on recovering this key object given its role in determining the optimal tariff.

Consistent with the modified golden rule savings rate in a neoclassical growth model, the optimal tariff is also quite different from the tariff that maximizes the long-run steady state utility. This casts doubt on the justification for using static models to recover an optimal tariff. While there may be a transformation of static models to make them informative for policy, it seems more fruitful to solve the infinite horizon model.

We also use our model to study how government credibility influences the path of tariffs. When the government can commit to a path of tariffs, it sets tariffs higher than the long-run and then quickly reduces those tariffs to a level below the one time change. When the government can not commit to future tariffs, but chooses them freely each period, we find the optimal time consistent steady state tariff is considerably larger than the welfare maximizing tariff. It is also much more closely related to the short-run trade elasticity than the long-run trade elasticity.

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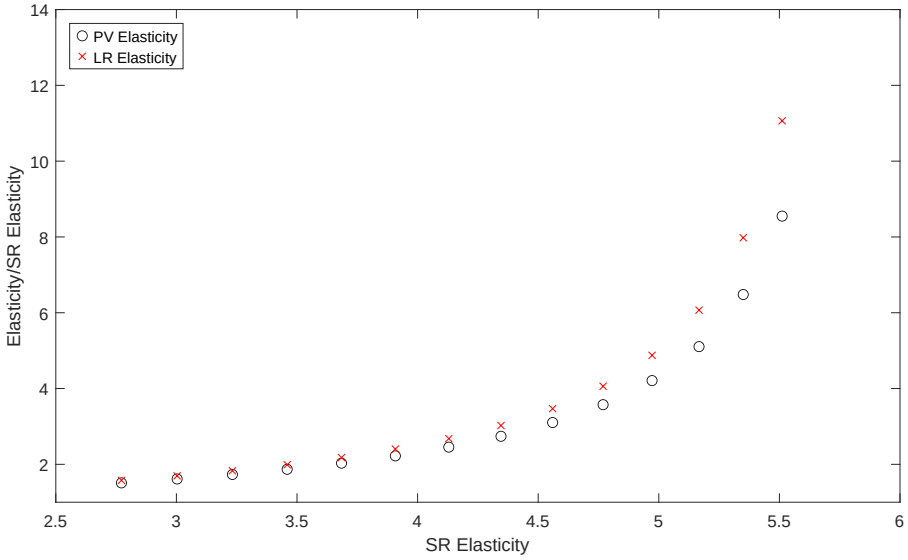


Figure 1: Present value and long-run trade elasticity against short-run trade elasticity

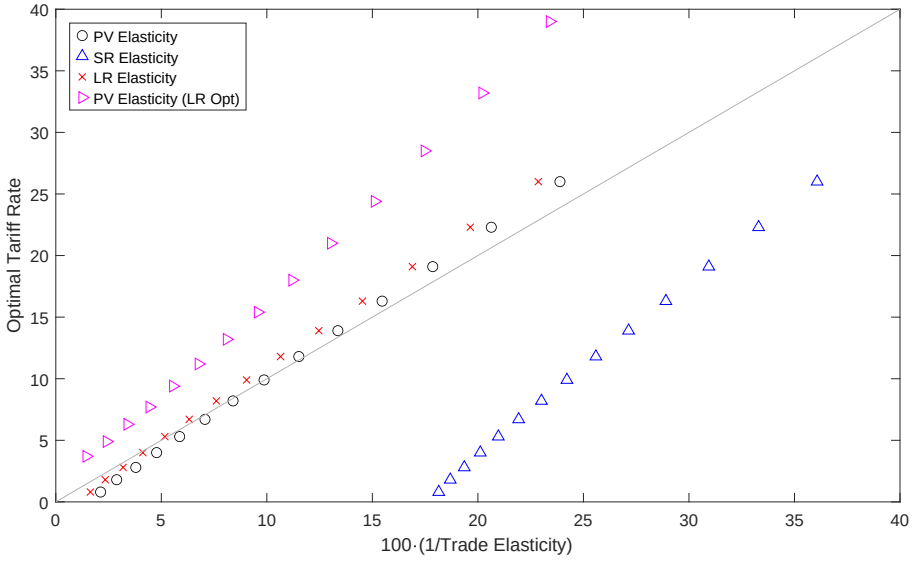


Figure 2: Optimal Tariff and Trade Elasticity

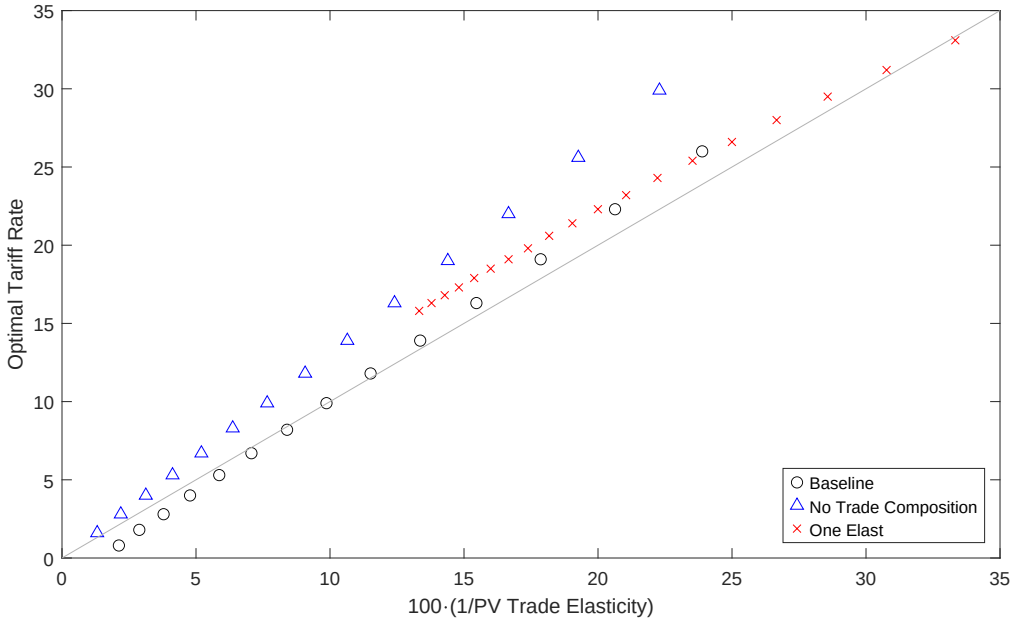


Figure 3: Optimal Tariff and Constant Elasticity

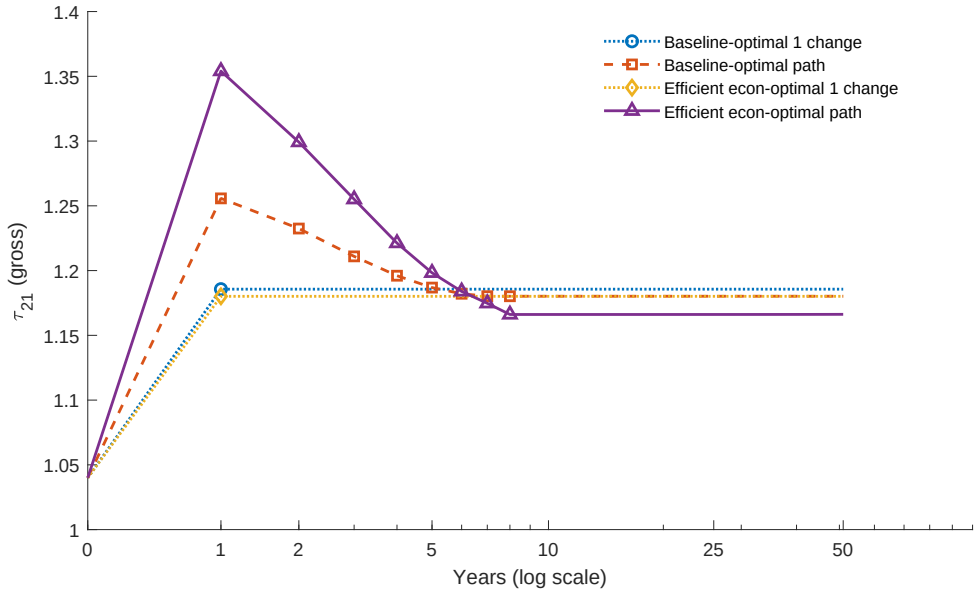


Figure 4: Optimal Tariff Path and Model Features

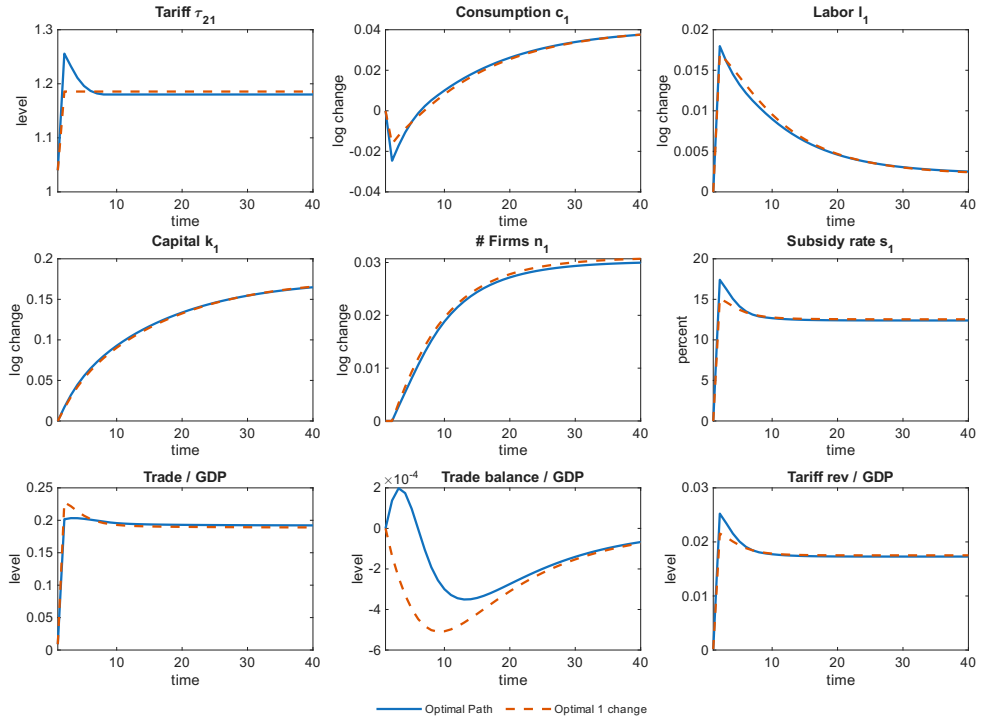


Figure 5: Macro Aggregates with Optimal Tariff Path

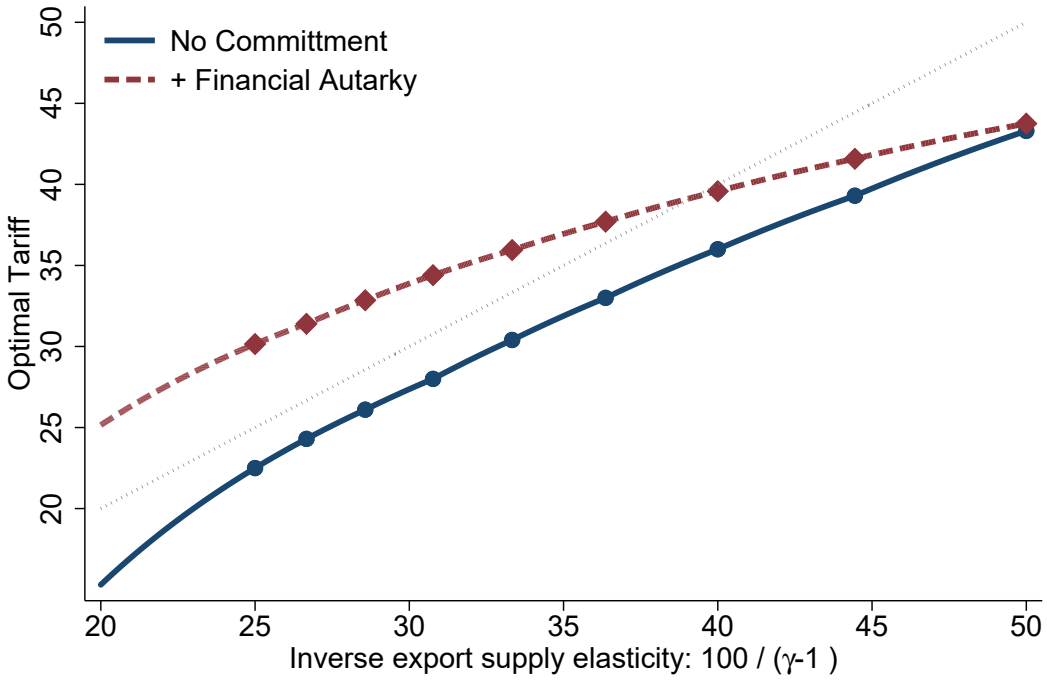


Figure 6: Optimal Tariff (Credibility and SR elasticity)

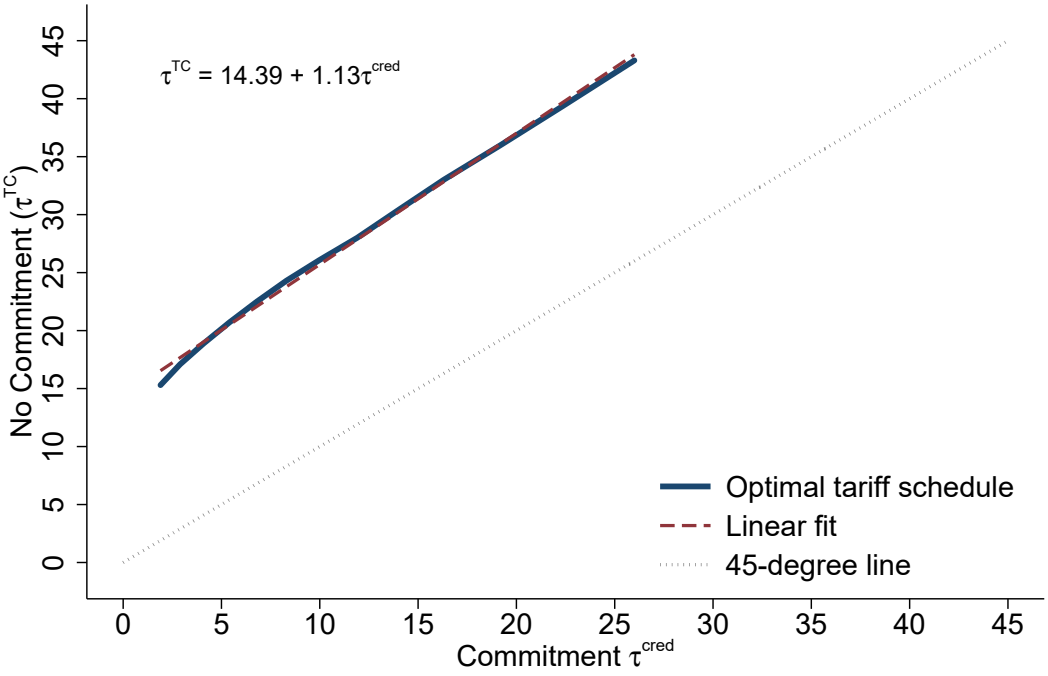


Figure 7: Optimal Tariff (Credibility vs Commitment)

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: Consumption-Equivalent Welfare Gains (%)

	Mean present value tariff	Welfare	Steady State
One Time	19.150	1.667	3.460
Steady State	25.000	1.562	3.564
Optimal Path	19.350	1.674	3.404
Optimal Path τ_∞	18.000		