POLITICAL ECONOMY PROTECTION AND FDI

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Abstract

In this paper, we develop an industry-specific partial equilibrium model that solves for the politically optimal tariff level following an unfavorable shock to production costs of domestic producers in the industry. We allow for the potential of inbound foreign direct investment (FDI) to circumvent increased tariff levels following the shock to domestic production. While many models abstract away from FDI changes because of a lack of fixed cost data, we use a method to approximate these costs to capture the likely scenario where foreign firms invest in local-affiliate production to continue serving the market. Assuming the pre-shock market was in equilibrium, we are able to calibrate the political-economy weight placed on the welfare of the firms that receive the shock using observable data and a grid of potential parameter values for unobservable parameters.

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1 Introduction

Trade agreements build in several means of flexibility to allow governments to respond to temporary shocks in their domestic market, including anti-dumping and countervailing duties, safeguards, and margins between the applied and bound tariff levels. Temporarily increasing tariff levels can increase competitiveness of domestic producers by lessening the flow of imports while domestic producers recover from a negative shock. In many cases, however, the increase in an applied tariff level induces tariff-jumping inbound foreign direct investment (FDI) by exporters trying to access the market. With high tariff barriers in place, it may be more profitable for larger foreign firms to serve the market through local affiliate production. On one hand, new inbound FDI may be at odds with the goal to boost existing domestic firms profitability and competitiveness. On the other hand, new FDI is welfare-enhancing as it brings new jobs to a market and allows consumers to purchase goods at lower prices. In this paper, we explore whether an increase in tariffs following a negative supply shock can both facilitate the adjustment of domestic production and also encourage inbound FDI in the sector receiving greater protection.

We develop an industry-specific model of trade policy. Using our model, we solve for the optimal tariff rate in three different scenarios: (i) when the government's objective is to maximize social welfare, (ii) when the government's objective is to maximize social welfare plus an additional weight on the welfare of the firms that receive the shock to marginal costs in the industry, and (iii) when the government's objective is to maximize social welfare plus an additional weight on all domestic production in the industry, including both domestic producers and producers previously established through inbound FDI. The model is at the firm level, assumes imperfect (Bertrand) competition, and uses a bounding method to calibrate the fixed costs of FDI and determine if it is profitable for a foreign exporting firm to switch modes of supply to local affiliate FDI.

In addition to examining the question of using tariff jumping to avoid an increased tariff level, key features of our model are the limited data requirements and the ability to use the model to calibrate several unobserved parameters. This includes the fixed costs of FDI mode-switching, the pre-shock production costs of the firms that receive the shock, and the political economy weight the government places on domestic producers.[1]

Through a series of illustrative simulations, our results indicate that an optimal tariff can both benefit the firms that receive the shock and induce new inbound FDI in the industry under consideration. We report findings of these simulations and discuss optimal tariff model outcomes under differing assumptions of the government's objective function. We also explore the sensitivity of the optimal tariffs and industry outcomes to different combinations of parameter values.

The rest of the paper proceeds as follows: first in Section 2, we describe the theory behind the model. Section 3 runs illustrative simulations to show how the model works, providing examples for each of the three simulations outlined above. In Section 4, we conclude with a discussion of model limitations and extensions.

2 Model

In this section, we build a model that can output an "optimal" tariff level to maximize government welfare while domestic producers adjust following a shock to their production costs. In choosing its optimal tariff, the government will also take into account the potential for inbound FDI by foreign firms seeking to circumvent the new tariff burden.

In Section 2.1, we describe the basic model setup for firms and consumers, including how tariff-jumping FDI is incorporated into the model. This section of the paper builds on the model used by Riker and Schreiber (2019). Then, we present the government optimization

[1]The production costs of the firms that receive the shock may be available from industry representatives.

problem in Section 2.2. We outline the timing of the model in Section 2.3. In Section 2.4, we describe the initial tariff level and how it relates to the post-shock economy, outlining observations that allow us to calibrate both the pre-shock production costs of the firm that receives the shock and the political economy weight the government places on that firm's welfare. Finally, we describe the government's choice of tariff level given the dynamics of the model in Section 2.5.[2]

As will be evident from the sections below, for this model to be applied to an industry, it must be true that there is (1) domestic production, (2) existing FDI in the domestic market, (3) at least one firm exporting into the home market, and (4) the total number of firms must be small enough to fit the assumption of Bertrand competition.

2.1 Basic Model

In this model, there are a small number of firms, N, that produce unique varieties of a differentiated good and sell to a single market. The home country imposes a most-favored-nation (MFN) tariff, τ, on all imports of the differentiated good from its trading partners.

Total utility from consumption of two goods, good 0 and good 1, is Cobb-Douglas with the price of good 0 normalized to one.

$$U = (q_0)^{\alpha}(q_1)^{1-\alpha}, \text{ with} \tag{1}$$

$$q_1 = \left(\sum_{n \in N} b_n^{\frac{1}{\sigma}} (q_{1n})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{2}$$

Consumers spend a constant share of income, α, on good 0 and share $1-\alpha$ on the

[2]Initially, we simplify the model such that the government changes the tariff for only one period while the shock-receiving firm works to recover, with the tariff in the post-shock period reverting to the initial (pre-shock) level. In later iterations of the model, we can add a dynamic policy option in which the government chooses the tariff level for multiple periods and chooses how long it will leave the tariff in place.

composite of good 1 varieties. Demand for varieties of the differentiated good is constant-elasticity of substitution (CES) with elasticity of substitution $\sigma > 1$ and with taste parameter b_n. We normalize b_1 to one without loss of generality. In the model, the shock occurs to a domestic firm producing good 1.

For this paper we assume that there are four types of firms: type-1 firms are local affiliates of foreign firms that were established through inbound FDI, type-2 firms are large producers abroad exporting to the home market that will consider jumping the increased tariff, type-3 firms are domestic producers, and type-4 firms are small exporters abroad. It is the domestic producers (type-3 firms) which receive an unfavorable shock to their marginal cost of production. For simplicity, we assume there are $N = 3 + N_4$ firms: one type-1 firm, one type-2 firm, and one type-3 firm, with $N_4 \geq 1$ type-4 firms that supply exports to the home country if the type-2 firm decides to tariff jump. We assume that the total number of firms over the time span of the model is fixed. Generalizing the model to a different N (such as allowing for multiples of each type of firm) is straightforward.

Corresponding to the utility functions, price indexes in the home country are

$$P = (P_0)^{\alpha} (P_1)^{1-\alpha}, \text{ and} \tag{3}$$

$$P_1 = \left(\sum_{n \in N} b_n \left((1+\tau_n) p_{1n}\right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{4}$$

where p_{1n} is the producer price of variety n in good 1, with τ_n equal to the tariff rate faced by firm n. For a firm that initially exports to the foreign market, $\tau_n = \tau^0$, with τ^0 equal to the initial tariff rate. For a domestic producer or for a firm that initially supplies the market through local affiliate FDI, τ_n is zero.

Given total expenditure on the combination of good 0 and good 1 is $v > 0$, demand for good 1 is a constant share of total expenditure:

$$d_1(P_1) = (1-\alpha)\,\frac{v}{P_1}. \tag{5}$$

The demand for variety n of good 1 is then calculated by maximizing the consumption index subject to the consumer's budget constraint:

$$d_{1n}(P_1, p_{1n}) = k\, b_n\, ((1+\tau_n)\, p_{1n})^{-\sigma}\, (P_1)^{\sigma-1}. \tag{6}$$

where $k \equiv (1-\alpha)\, v$ is a demand parameter representing market size.

As for production, the numeraire good, good 0, is produced using only labor, $q_0 = l_0$, which pins down the wage in the home country at one. Good 1 is also produced using only labor, with constant unit-labor-input requirement, c_n, such that $q_{1n} = (1/c_n)\, L_{1n}$. Given that the wage is pinned down at one, this means that c_n is also the constant marginal cost of production of variety n.

The variable portion of firm n's operating profits is $\pi_{1n} = (p_{1n} - c_n)\, q_{1n}$, which can be rewritten plugging in the definition of demand from equation (6) and the definition of the price index from equation (4), giving

$$\pi_{1n} = (p_{1n} - c_n)\, k\, ((1+\tau_n)\, p_{1n})^{-\sigma}\, b_n \left(\sum_{m \in N} b_m\, ((1+\tau_m)\, p_{1m})^{1-\sigma} \right)^{-1}. \tag{7}$$

Because firm n maximizes profits taking the other $n-1$ prices as given, the profit-maximizing producer price is

$$p_{1n} = c_n \frac{\sigma - (\sigma-1)\left[\frac{v_n}{v_1+v_2+v_3+N_4\, v_4}\right]}{\sigma - (\sigma-1)\left[\frac{v_n}{v_1+v_2+v_3+N_4\, v_4}\right] - 1}, \tag{8}$$

with v_n equal to the expenditure on variety n of the differentiated good.

In addition to the standard Bertrand pricing decision, exporting firms (firm 2 and the type-4 firms) must also choose a mode of supply: they can either continue to export, or choose to change production locations to the tariff-setting country.

Our interest in modeling inbound FDI in part stems from the challenge of constructing a model that predicts new FDI as a result of changes in trade policy. Modeling market entry through FDI typically requires knowing fixed costs in addition to introducing a discontinuity in firms' decision making. Because we do not observe fixed costs, we use the methodology presented in Riker and Schreiber (2019) to calculate bounds on fixed costs based on the observed initial equilibrium, in which there is at least one firm that exports to the domestic and one firm that has already chosen to establish a local affiliate through FDI. To calculate bounds on fixed costs, we first define variable profits a firm would earn if it had deviated from its status quo strategy, holding the other firm strategies as fixed:

$$\pi^*_{1n}(\tau^*_n) = \frac{\left(p^*_{1n} - \frac{c_n}{\omega}\right) \, k \, \left(p^*_{1n}\left(1+\tau^*_n\right)\right)^{-\sigma} b_n}{b_n \left(p^*_{1n}\left(1+\tau^*_n\right)\right)^{1-\sigma} + \sum_{i \neq n} b_i \left(p_{1i}\left(1+\tau_i\right)\right)^{1-\sigma}}, \tag{9}$$

where ω is a relative wage parameter that allows the model user to increase or decrease marginal costs after switching production locations.[3] An asterisk (*) label indicates that the variable is a deviation from the initial status quo strategy. If firm n was initially an exporting firm and switched to local affiliate production, then π^*_n represents deviation profits from local affiliate FDI, τ^*_n is zero, and $i \neq n$ are initial equilibrium values because firm n holds the other firm's strategies as fixed.

To calculate bounds on fixed costs of switching to FDI, we first solve for optimal prices and calculate optimal profits for the firm originally exporting (firm 2) and for the firm serving through local affiliate FDI (firm 1). Equation (10) then provides an upper bound and a lower

[3]For the purposes of interpreting ω, when $\omega > 1$ the tariff-setting (home) country's wage is higher than the exporting country's wage.

bound for the fixed costs in an industry:

$$\pi^*_{12}(\tau^*_2 = 0) - \pi_{12}(\tau_2 = \tau^0) < f < \pi_{11}(\tau_1 = 0) - \pi^*_{11}(\tau^*_1 = \tau^0), \tag{10}$$

where the tariff level faced by firm n is denoted by τ_n and the deviation tariff value for firm n is τ^*_n. This gives us a bound on the fixed costs of switching modes of supply to local affiliate FDI. Setting up equation (10) provides us with a way to calibrate fixed costs in applications of the model and determine whether or not firm 2 will tariff jump due to an increase in the tariff, τ^*_n.[4]

In our model simulations, we assume the actual fixed cost of a firm choosing FDI is the average of the upper and lower bound established by equation (10).[5] With this average value of the fixed cost, we are then able to solve the government's dynamic optimization problem taking into account that the new optimal tariff will potentially induce exporting firms to tariff jump.

2.2 Government Optimization Problem

The government sets the tariff on imports of good 1 to maximize the sum of social welfare and politically weighted profits of the domestic producers. Government welfare is defined as:

$$G = a\left[CS + \Pi_0 + \sum_{n \neq 1,3} \Pi_{1n} + \tau M_1 + w\, L\right] + \psi\, \Pi_{11} + \Pi_{13}, \tag{11}$$

where $CS \equiv U - q_0 - P_1 q_1$ is consumer surplus given good 0 is the numeraire good; $\Pi_0 = q_0 - w\, L_0$ is the profits from good 0; $\Pi_{1n} = \pi_{1n} - f_n = p_{1n}\, q_{1n} - w\, L_{1n} - f_n$ is profits of variety

[4] Given the four firm-type setup of the model we present here, this means that the incentive constraint in equation (10) also applies to type-4 firms. Since we assume firm 2 is the larger exporter, however, firm 2's incentive constraint will generate the binding constraint on the bounds of the fixed cost.

[5] This is similar to assuming the fixed cost of a firm choosing FDI is drawn from a uniform distribution between the upper and lower bound established by equation (10).

n of good 1 (with π_{1n} representing firm n's operating profits) and f_n is the fixed cost firm n must pay to participate in their preferred mode of supply (i.e. $f_n = f$ for a firm choosing to tariff jump, otherwise $f_n = 0$); $M_1 = p_{12}\, q_{12} + N_4\, p_{14}\, q_{14}$ is revenue from imports of good 1, which are subject to ad valorem tariff $\tau > 0$ for all varieties; and $w\, L$ is labor income.

The final two parameters of interest in equation (11) are the two political economy weights: a and ψ. The traditional political economy weight, $a \in [0, 1]$, is defined in the manner of Grossman and Helpman (1994) such that $a < 1$ implies the government places additional weight on the domestic producers' (firm 1 and firm 3's) welfare. The additional political economy parameter, $\psi \in [a, 1]$, is an additional level of flexibility in our model which allows the government to value the domestic firm's (firm 3's) welfare differently from the local affiliate FDI firms. When $\psi = a$, the government places no political economy weight on profits of firm 1. When $\psi \in (a, 1)$, the government places a political economy weight on profits of firm 1 that is less than the weight it places on firm 3. When $\psi = 1$, the government places the same political economy weight on firm 1's profits as it does the domestic firm that received the shock to marginal cost. In our simulations, we assume $\psi \in (a, 1)$.

Note that our theoretical model makes strong assumptions about the government's welfare equation, which may or may not reflect the government's actual objective function in setting tariffs. We do not claim that equation (11) is the only possible representation of government welfare.

Plugging in the definitions of consumer surplus, demand, and imports; given that there are four firm types in the sector; and given that the government's choice of tariff will influence whether or not firms exporting to the market decide to tariff jump, the government welfare equation can be written

$$G = a\Bigg[\Big((q_0)^{\alpha}(q_1)^{1-\alpha} - v\Big) + \mathbb{I}_{\text{Jump},2}\Big(\,(p_{12} - \omega\, c_2)\; q_{12} - f\Big) + \mathbb{I}_{\text{Jump},4}\; N_4\Big(\,(p_{14} - \omega\, c_4)\; q_{14} - f\Big) + (1 - \mathbb{I}_{\text{Jump},2})\,\tau\, p_{12}\, q_{12} + (1 - \mathbb{I}_{\text{Jump},4})\, N_4\,\tau\, p_{14}\, q_{14}\Bigg] + \psi\,(p_{11} - c_1)\, q_{11} + (p_{13} - c_3)\, q_{13}\,, \tag{11'}$$

where any profits from good 0 are ignored in this equation due to their independence from the tariff on good 1. The indicator, $\mathbb{I}_{\text{Jump},n}$, is equal to one if firm n decides to tariff jump.[6]

2.3 Timing of the Model

As already discussed, dynamics are an essential feature of our model. For simplicity, we consider a four-period model in which the government can only increase the tariff for one period, the period in which the domestic producer is producing at the higher marginal cost, and then it reverts to the original level. The details of the timing of the tariff changes and the adjustment by firms are as follow:

- **Period -1: Pre-shock stage.** Domestic market is in equilibrium, tariff τ^0 optimizes government welfare;

- **Period 0: Initial state.** Domestic producer, firm 3, loses market share from a shock and the government decides to grant the sector temporary protection from imports, the government then determines the optimal tariff, $\tau^{'}$, to maximize expected welfare for the remaining two periods;

- **Period 1: High-tariff period.** New optimal tariff enters into force on imported varieties of good 1, firm 3 produces at the high marginal cost in this period, exporting

[6]We assume that even if firm 2 chooses to tariff jump, it will not immediately be viewed as a "domestic producer" by the government in setting its tariff.

firms choose whether or not to tariff jump to avoid the tariff increase;

- **Period 2: Post-shock period.** Firm 3 exogenously recovers to original marginal costs of production, tariff returns to τ^0.

A key point to note is that the government's dynamic optimization problem maximizes welfare given the potential for the increased tariff level causing an influx of FDI from foreign firms.

Additional richness to the model could be introduced by allowing the government to choose how long to increase the tariff following the shock or by modeling the recovery process for the firm that receives the shock to marginal cost.

2.4 Calibrating Unobserved Parameters Using the Initial State of Domestic Market

This section outlines how we can use the observed initial state of the domestic industry to infer how the shock to firm 3, the domestic producer, impacted its marginal cost of production. We also describe how the initial state of the economy can be used to estimate the political economy weight the government places on the welfare of the domestic firm.

The model assumes a few things about the initial state in the home economy: first, initial production is at equilibrium levels. Second, the initial tariff, τ_0, is a commitment from before the shock to the domestic firm's production costs occurred.

We make limited assertions regarding the shock: we assume that an exogenous increase in the domestic producer's (firm 3's) marginal cost of production resulting in a loss of competitiveness and subsequent loss in market share.

The initial tariff level is the result of a static optimization problem that we do not observe within the model. By the point we reach period 0, the negative shock has already occurred in the domestic market. As a result, the government's welfare, G, is not maximized: the initial tariff level, τ^0, falls below the level that would maximize period 0 welfare. In other terms, the period 0 first-order condition of government welfare is

$$\begin{aligned} \left.\frac{dG^0}{d\tau}\right|_{\tau=\tau^0} &= a\left[\frac{\partial CS^0}{\partial \tau} + M_1(\tau^0) + \tau^0 \frac{\partial M_1(\tau^0)}{\partial \tau^0}\right] \\ &\quad + \psi\left(p^0_{11} - c_1\right)\left(\frac{dq_{11}}{dP^0_1}\frac{\partial P^0_1}{\partial \tau^0}\right) + \left(p^0_{13} - c_3\right)\left(\frac{dq_{13}}{dP^0_1}\frac{\partial P^0_1}{\partial \tau^0}\right) > 0, \end{aligned} \tag{12}$$

where the total derivative of operating profits, $\pi_{1n} = (p_{1n} - c_n)\, q_{1n}$, with respect to p_{1n} is equal to zero by the envelope condition from the firm's profit maximization problem; and with the derivative of consumer surplus and of imports defined as follows:

$$\begin{aligned} \frac{\partial CS}{\partial \tau} &= \sum_{n\in N}(1-\alpha)\left(\frac{q_0}{q_1}\right)^{\alpha}(b_n\, q_1)^{\frac{1}{\sigma}}(q_{1n})^{-\frac{1}{\sigma}}\left(\frac{dq_{1n}}{dp_{1n}}\frac{dp_{1n}}{d\tau} + \frac{dq_{1n}}{dP_1}\frac{dP_1}{d\tau}\right), \\ \frac{\partial M_1(\tau)}{\partial \tau} &= \sum_{n\neq 1,3}\left(p_{1n}\frac{dq_{1n}}{dp_{1n}}\frac{dp_{1n}}{d\tau} + p_{1n}\frac{dq_{1n}}{dP_1}\frac{dP_1}{d\tau}\right). \end{aligned}$$

Given that τ^0 is below the equilibrium level, the second-derivative of the welfare equation at τ^0 must be negative. This fact can be used in the calibration of model parameters.

We assume the shock affects the marginal cost of production for the domestic variety of good 1. As part of calibrating the simulation of the model, we use this assumption to help us pin down reasonable model parameters. Specifically, there are constraints on period -1, the period before the model begins and before the shock to domestic producers occurs: in period -1, the tariff level, τ^0, must optimize government welfare given $c_3 = c_3^{-1}$. Therefore, it must be true that

$$\begin{aligned} \frac{dG^{-1}(\tau^0, c_3^{-1})}{d\tau} &= a\left[\frac{\partial CS^{-1}(\tau^0, c_3^{-1})}{\partial \tau^0} + M_1^{-1}(\tau^0, c_3^{-1}) + \tau^0 \frac{\partial M_1^{-1}(\tau^0, c_3^{-1})}{\partial \tau^0}\right] \\ &\quad + \psi\left(p^{-1}_{11} - c_1\right)\frac{dq^{-1}_{11}}{dP_1}\frac{dP_1(\tau^0, c_3^{-1})}{d\tau^0} + \left(p^{-1}_{13} - c_3^{-1}\right)\frac{dq^{-1}_{13}}{dP_1}\frac{dP_1(\tau^0, c_3^{-1})}{d\tau^0} = 0, \end{aligned} \tag{13}$$

where in period -1 the marginal cost for the domestic variety is $c_3^{-1} < c_3^0$.

Additionally, in period -1 the exporting firms must have no incentive to tariff jump:

$$\pi_{1n}(\tau^0, c_3^{-1} | \mathbb{I}_{\text{Jump},n} = 0) \geq \pi_{1n}(\tau^0, c_3^{-1} | \mathbb{I}_{\text{Jump},n} = 1) - f, \tag{14}$$

for $n \in \{2, 4\}$, where f is the fixed cost to a firm of setting up operations in the tariff-setting country. Using these facts, and knowing how much market share of the domestically produced varieties of the differentiated good has fallen, we are able to calibrate the political economy weight on the domestic producer's welfare. More specifically, given the market share of the domestic firm (firm 3) after the shock occurs, $p_{13}\, q_{13} / \left(\sum_{n \in N}(1+\tau_n)\, p_{1n}\, q_{1n}\right)$, we suppose that the pre-shock market share of domestically produced varieties was $\delta \in (0, 1)$ larger in period -1 than it is in period 0, caused by a change in the firm type 3's marginal cost of production, c_3, so that

$$\frac{p_{13}^{-1}(\tau^0, c_3^{-1})\, q_{13}^{-1}(\tau^0, c_3^{-1})}{\sum_{n \in N}(1+\tau_n)\, p_{1n}^{-1}(\tau^0, c_3^{-1})\, q_{1n}^{-1}(\tau^0, c_3^{-1})} = (1+\delta)\, \frac{p_{13}^{0}(\tau^0, c_3^{0})\, q_{13}^{0}(\tau^0, c_3^{0})}{\sum_{n \in N}(1+\tau_n)\, p_{1n}^{0}(\tau^0, c_3^{0})\, q_{1n}^{0}(\tau^0, c_3^{0})}. \tag{15}$$

We are then able to plug in the calibrated value of c_3^{-1} into equation (13) and solve for the political economy weight, a, that is consistent with τ^0 being the solution to equation (13).

2.5 Simple Dynamic Optimization of the Tariff

In this section we outline how we solve for the optimal tariff level given the model described above. The government chooses $\tau' > \tau^0$ to maximize the present discounted value of its stream of welfare, given period 1 welfare when the tariff is at the higher level in response to the domestic shock, τ', and period 2 welfare when the tariff level returns to the original value, τ^0:

$$V(\tau') = G^1(\tau', c_3^0) + \beta\, G^2(\tau^0, c_3^2 | \tau^1 = \tau'), \tag{16}$$

where $\beta \in (0,1)$ is the discount factor. The welfare in period 2, G^2, is dependent on the tariff level in period 1, because the tariff level, τ^1, is what determines whether or not exporters will choose to tariff jump and begin operations in the home country instead of continuing to export. Because we assume the shock occurs to the marginal cost of production for the home variety, we again assume that the adjustment undertaken by the domestic firm during the high-tariff period impacts the marginal cost parameter. The new value of firm 3's marginal cost following the high-tariff-period adjustments is c_3^2.

The government's optimal tariff, τ', must solve

$$\begin{aligned}\frac{dV(\tau')}{d\tau} = a \Bigg[& \frac{\partial CS^1(\tau', c_3^0)}{\partial \tau} + \beta \, \frac{\partial CS^2(\tau^0, c_3^2 | \tau^1 = \tau')}{\partial \tau} + M_1^1(\tau', c_3^0) + \tau' \frac{\partial M_1^1(\tau', c_3^0)}{\partial \tau} \\ & + \beta \, M_1^2(\tau^0, c_3^2 | \tau^1 = \tau') + \beta \, \tau^0 \, \frac{\partial M_1^2(\tau^0, c_3^2 | \tau^1 = \tau')}{\partial \tau} \\ & + \sum_{n \neq 1,3} \mathbb{I}_{\text{Jump,n}} (p_{1n}^1 - c_n) \frac{dq_{1n}^1}{dP_1} \, \frac{dP_1(\tau', c_3^0)}{d\tau} \\ & + \beta \sum_{n \neq 1,3} \mathbb{I}_{\text{Jump,n}} (p_{1n}^1 - c_n) \frac{dq_{1n}^1}{dP_1} \, \frac{dP_1(\tau^0, c_3^2 | \tau^1 = \tau')}{d\tau} \Bigg] \\ & + \psi \, (p_{11}^1 - c_1) \frac{dq_{11}^1}{dP_1} \, \frac{dP_1(\tau', c_3^0)}{d\tau} + \psi \, \beta \, (p_{11}^2 - c_1) \frac{dq_{11}^2}{dP_1} \, \frac{dP_1(\tau^0, c_3^2 | \tau^1 = \tau')}{d\tau} \\ & + (p_{13}^1 - c_3^0) \frac{dq_{13}^1}{dP_1} \, \frac{dP_1(\tau', c_3^0)}{d\tau} + \beta \, (p_{13}^2 - c_3^2) \frac{dq_{13}^2}{dP_1} \, \frac{dP_1(\tau^0, c_3^2 | \tau^1 = \tau')}{d\tau} = 0, \end{aligned} \tag{17}$$

where period 2 welfare is again dependent on the history of the tariff level, given that the increased tariff level determines whether or not exporters tariff jump in period 1. Additionally, the second derivative of welfare with respect to the tariff level must be negative at the increased tariff, τ', for the policy to be welfare maximizing.

As mentioned previously, we assume the negative shock leading to the the government's decision to increase the tariff level is a shock to the marginal cost of production for the domestic variety of good 1, c_3. We assume that during period 1, firm 3 takes the necessary steps to ensure that its parameter, c_3, returns to the pre-shock level that solves equation

(15). In other terms, they go from c_3^0 (in periods 0 and 1) to $c_3^2 = c_3^{-1}$ in period 2.[7]

Given that the tariff increase may induce exporters to tariff jump, the government's optimization problem also takes into account the exporter's tariff jumping decision. Firm n chooses to tariff jump in period 1 (denoted by the indicator variable $\mathbb{I}^1_{\text{Jump},n} = 1$) in response to the tariff increase if

$$\begin{aligned} &\pi_{1n}(\tau'|\mathbb{I}^1_{\text{Jump},n} = 1) + \beta\, \pi_{1n}(\tau^0|\mathbb{I}^1_{\text{Jump},n} = 1) - f_n \\ &\qquad\qquad > \pi_{1n}(\tau'|\mathbb{I}^1_{\text{Jump},n} = 0) + \beta\, \pi_{1n}(\tau^0|\mathbb{I}^1_{\text{Jump},n} = 0), \end{aligned} \tag{18}$$

with $\tau_n^1 = \tau'$ and $\tau_n^2 = \tau^0$ if variety n is imported to the home country, and where $\tau_n^t = 0$ if n is a domestically-produced variety of good 1.[8]

3 Illustrative Simulations

In this section, we present the results of a series of simulations to illustrate how the model works. Note that all input data used in this section is meant to be illustrative and is not representative of an observed tariff adjustment.

We first outline the aspects of the model that are calibrated in Section 3.1. Then, we present the first set of solutions in Section 3.2. This section presents the results of the model when the government maximizes social welfare, where we assume that the government does not place any additional weight on the profits of firms in the shock-receiving industry. In other terms, this section assumes that $a = \psi = 1$ in equation (11). In this section, we first run the model over a small grid of values of the substitution elasticity σ and relative wage ω and present model outcomes. Then, in Section 3.2.1, we expand the grid of σ and ω

[7] As mentioned previously, a future extension of the theoretical model would be to make the recovery of the domestic producer costly, instead of allowing them to automatically revert to c_3.

[8] Note that if firm n is indifferent between tariff jumping and not, it chooses to maintain "status quo" and not tariff jump.

values to show the sensitivity of model solutions. Section 3.3 presents results for the political economy version of the model, allowing both a and ψ to take on values other than 1. Due to difficulties with solving the numerical model, we do not provide results for the expanded grid of parameters for that version of the model.

Other than the political economy parameters, the parameters we use in the estimations in Sections 3.2 and 3.3 are the same, outlined in Table 1. We initially consider two possible elasticity of substitution values ($\sigma \in \{2, 2.25\}$) and two possible relative wage parameters ($\omega \in \{0.3, 0.5\}$). For $\omega < 1$, the tariff-setting (home) country's wage is lower than the wage in the exporting country.[9] This parameter is used when the model calculates FDI changes for the exporting firm.

Table 1: Parameter Inputs for Illustrative Simulations

Parameter	Value
Share of good 1 varieties in total expenditure, α	1/2
Elasticity of substitution, σ	$\{2, 2.25\}$
Relative wage parameter, ω	$\{0.3, 0.5\}$
Discount factor, β	0.95
Initial tariff rate on imports, τ^0 (%)	7.5
Trade friction (%)	2.5
Initial expenditure on each firm type ($\{v_1, v_2, v_3, v_4\}$)	{500, 300, 100, 100}
Number of type-4 firms	5
Shock to market share of domestic producer, δ (%)	20

Values in the second half of the table—the initial tariff level, trade frictions, and the initial market share of each firm in the home country—are largely observable. We use an initial tariff rate of 7.5% and a 2.5% trade friction that may be thought of as transportation costs. The values we choose for the initial market shares are intended to present a scenario

[9] Due to sensitivity of the estimates to the parameter choices, we have reported results only for $\omega < 1$. In the future, it may be necessary to add additional frictions or modify the government welfare equation to improve the model's ability to find an optimal tariff for a larger range of parameters, including when $\omega > 1$. An ω value less than 1 might be most appropriate for cases where the tariff-setting country is a developing economy.

in which there is a domestic producer, a large firm that chose to tariff jump sometime before period 0, a large exporter that has not yet tariff jumped in period 0, and a small number of exporters (type-4 firms) that have also not yet chosen to tariff jump.[10] The shock which induced the tariff adjustment, the market share lost by the domestic producer (firm 3), δ, is set to 20%.

As discussed earlier, we assume firm 3 works to improve its marginal cost during the high-tariff period, with it's marginal cost returning to the pre-shock level after the high-tariff period.

3.1 Model Calibration and Tariff Solutions

Using the numbers in Table 1, several aspects of the model simulation can be calibrated. First, model parameters $\{k,\, b_n,\, c_n\}$ are calibrated using the initial equilibrium values and assumed elasticity parameter values. To begin, we set initial firm prices to one without loss of generality. This allows us to calibrate the marginal costs and the taste parameters.

In Section 2.1, we discussed how the bounds of the fixed costs of tariff jumping are calibrated using the methodology of Riker and Schreiber (2019): because we assume firm 1 did tariff jump at the initial equilibrium tariff level, τ^0, and firms 2 and 4 did not, we can pin down the possible range of the fixed cost of tariff jumping (equation (10)). We then assume the actual fixed cost is the midpoint of the range corresponding to the fixed cost bounds and use this value for the model simulations.

In Section 2.4, we show that using equation (15), we can calibrate the pre-shock marginal cost of production for the firm that receives the shock to marginal cost, c_3^{-1}. We report the results for the marginal cost calibration for the simulation with social-welfare maximization in Section 3.2 and with politically-weighted welfare maximization in Section 3.3. Given that

[10]The shares we use imply that domestic production (firm 1 and firm 3) accounts for about 43% of domestic sales and that the firm 3 accounts for about 17% of the domestic market.

the shock led to a decrease in market share for firm 3, the calibrated marginal cost for period -1 should be greater than the marginal cost in period 0.

In Section 2.4, we also showed that the political economy weight, a, can be calibrated using the government's period -1 welfare maximization problem (equation (13)). We report these results in Section 3.3.

In Section 2.5, we showed that the optimal tariff level must maximize the present-discounted-value of government welfare for periods 1 and 2, given that firm 2 may choose to tariff jump and firm 3 uses the high-tariff period to recover its market share to the original level. Therefore, equation (17) must hold subject to the constraint defined in equation (18). The results of the tariff optimization are reported for the scenarios with and without political economy pressure in Sections 3.2 and 3.3, respectively.

3.2 Results of Illustrative Simulations with Social Welfare Maximization

In this set of simulations, we assume that the government places equal weight on each component of the welfare equation, meaning both political economy weights, a and ψ, are equal to one and the government sets the tariff to maximize social welfare.

Before reporting the results of the tariff optimization, we first report the calibrated value of the pre-shock marginal cost of production for the domestic firm that receives the shock to marginal cost. These results are in Table 2. Comparing the results for two values of σ, the percentage increase in marginal cost that led to the 20% market share decrease is decreasing in σ. Expanding the grid of σ's and solving for the calibrated pre-shock marginal cost demonstrates that this pattern is consistent across a larger range of σ values. This reflects the fact that as goods become more differentiated (for higher σ), a smaller change in marginal cost is required to lose market share, since consumers are more sensitive to price.

Table 2: Change in Marginal Cost Leading to Tariff Increase

σ	Calibrated Pre-shock Marginal Cost (c_3^{-1})	Marginal Cost After Shock (c_3^0)	Percent Change From Period 1 to Period 2 ($(c_3^0 - c_3^{-1})/c_3^{-1}$)
2	0.3670	0.4808	31.02%
2.25	0.4316	0.5365	24.30%

Table 3: Simulation Results: Optimal Tariffs

σ	ω	Tariff Jump?	τ_1^{Opt}
2	0.3	True	0.317
2	0.5	True	0.525
2.25	0.3	True	0.446
2.25	0.5	True	0.748

Table 3 presents the optimal tariff outcomes by parameter combination. In all cases considered, the large exporting firm (firm 2) changes modes of supply to local affiliate FDI. For the values of σ in our main set of estimates, tariff rates are increasing in the elasticity of substitution σ. This reflects the fact that a higher tariff rate is required to maximize welfare as the product under consideration becomes more substitutable with imports.[11]

Table 4 shows how increasing the tariff level in response to the shock affects the market share of each type of firm in the domestic industry. First, local affiliates lose market share as they are now forced to compete with the additional large exporter that tariff jumped. The large exporter gains significant market share after tariff jumping. The large exporter can lower its prices after changing modes of supply: they are no longer subject to trade costs and trade frictions, and they now pay a lower relative wage, lowering the marginal cost of production. The domestic firm initially loses even more market share in the high-tariff period (period 1) due to the fact that they are still operating at their shock-induced marginal

[11] As we discuss in Section 3.2.1, optimal tariff rates are actually non-linear in σ. This can be observed when the range of elasticities is expanded for the sensitivity analysis. We discuss the non-monotonicity of this relationship further there.

cost, c_3^0, and due to the effect of the large exporter tariff jumping. By period 2, however, the domestic firm recovers its marginal cost to c_3^{-1} and increases their market share significantly compared to the period 0 levels. Finally, the small exporter firms lose market share as they now face a higher tariff rate to serve the market.

Table 4: Effect of Tariff Increase on Market Share, Percent Change Compared to Period 0

	σ=2 ω=0.3	σ=2 ω=0.5	σ=2.25 ω=0.3	σ=2.25 ω=0.5
Period 1 percent change in home market share:				
Local Affiliate	-105.2	-27.25	-125.3	-22.86
Large Exporter (after tariff jump)	366.9	246.7	461.1	319.2
Domestic Firm	-27.34	-8.867	-32.67	-8.035
Small Exporter	-38.41	-34.13	-50.92	-48.26
Period 2 percent change in home market share:				
Local Affiliate	-132.2	-77.56	-168.0	-94.36
Large Exporter (after tariff jump)	333.9	197.7	405.4	244.1
Domestic Firm	20.58	41.19	47.27	26.4
Small Exporter	-30.55	-18.65	-38.48	-22.98

The effect of the increased tariff on prices, quantities, and each part of the government welfare equation are available in appendix tables 9 and 10.

3.2.1 Sensitivity of Estimates

In this section, we explore the model results for a wider range of values of the elasticity of substitution, σ, and the relative wage of the tariff-setting country, ω, to test sensitivity of model results. We define a grid of possible σ and ω parameter values and solve the model for all combinations of the two parameters. For our sensitivity analysis, the elasticity of substitution ranges from 1.25 to 5.75, and the relative wage ranges from 0.3 to 1.05.

Figure 1 shows existence of optimal tariff solutions for all σ and ω grid points. For low enough σ values, the model cannot arrive at a solution. When σ is high, the model also has trouble finding the politically optimal tariff level.

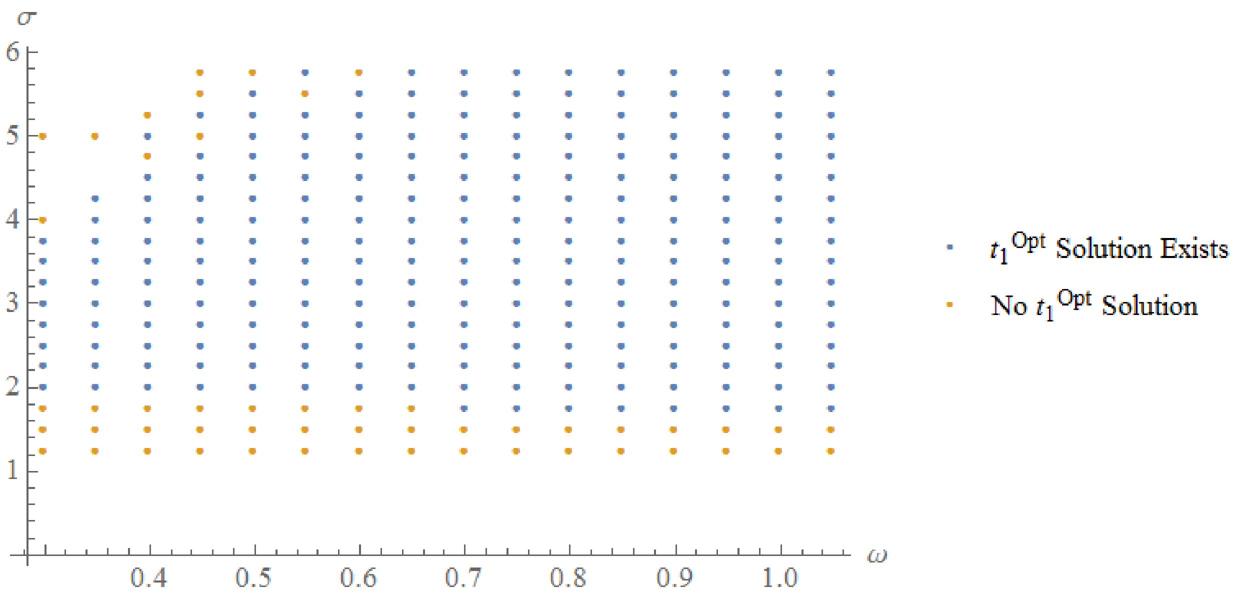

Figure 1: Parameter Grid and Optimal Tariff Existence

For a selection of the grid points where a solution exists, Figure 2 shows the optimal tariff rate as it relates to σ for varying levels of ω. By zooming out on the range of σ's and ω's, we are able to see that the observed pattern in Table 3 is slightly different than what appears here: while Figure 2 does confirm that the optimal tariff is monotonically increasing in the relative wage of the tariff-setting country, it also shows that the slope of the optimal tariff line is non-monotonic in σ. The non-monotonicity of the optimal tariff for different values of σ is unsurprising given the complex way that the elasticity of substitution enters into the model.

Future versions of the model could incorporate more frictions to improve the model's ability to find solutions for a wider range of parameters and to improve the optimal tariff results. A temporary tariff increase to 200%, for example, is highly unlikely to be implemented.

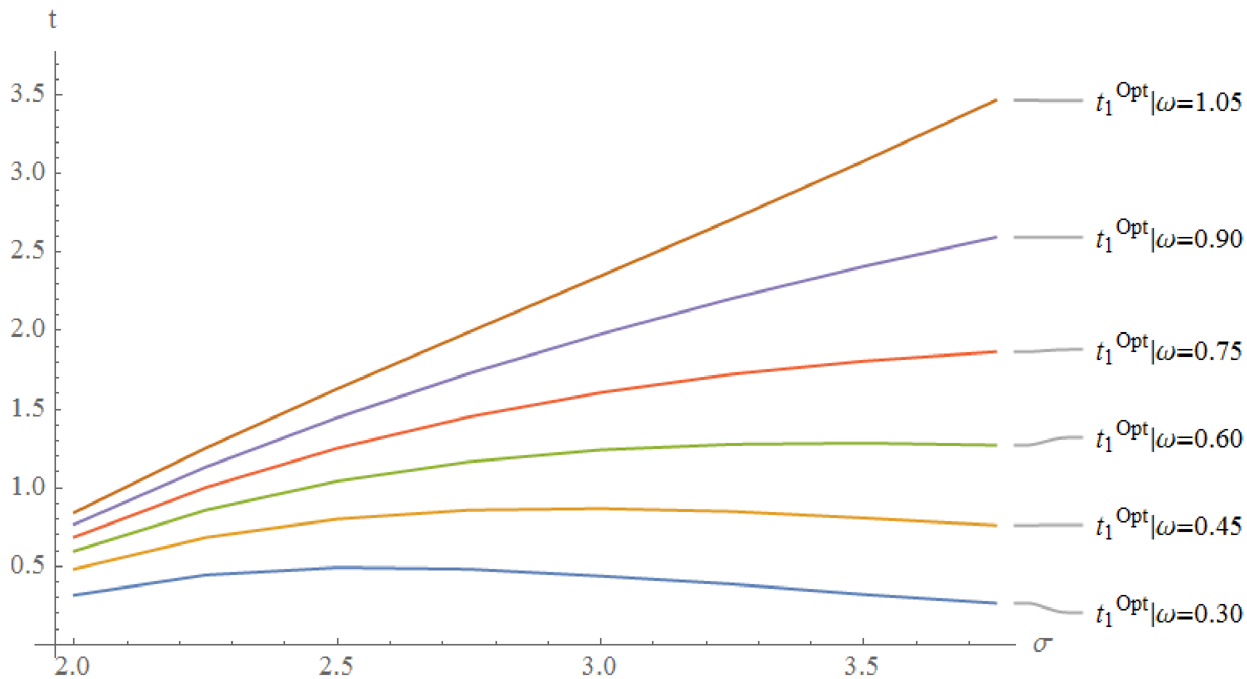

Figure 2: Optimal Tariffs for Different σ and ω Values

3.3 Results of Illustrative Simulations with Political Economy Pressure

This section presents the results of the model when calibrating the political economy parameter, a, using the method discussed in Section 2.4. Note that although we can calibrate a, the model user must input the relative weight placed on the welfare of existing local affiliate firms, ψ. For the hypothetical industry we model here, we run the simulations for two possible scenarios. First, we assume the government does not place any political economy weight on local affiliate production. These results are reported in Table 7. Next, we assume the government does place some political economy weight on the local affiliate firms, but that this weight is significantly lower than the weight it places on the domestic firm: we set this parameter at $1.5\,a < 1$ in our simulations. This is equivalent to assuming the government places 1.5 times as much weight on local affiliate production when choosing the optimal tariff level as it does the rest of social welfare. These results are reported in

Table 8.

Table 5 shows the calibrated value of the marginal cost for both versions of the political economy simulation. The calibration of the marginal cost parameter is independent of the political economy weights (see equation (15)), so it is the same regardless of the value of a or ψ we use in the estimate. Comparing this to Table 2, the percentage change in marginal cost that led to the 20% fall in market share is very similar in the two simulations, and again, the change in marginal cost that led to the 20% fall in market share is decreasing in the value of σ.

Table 5: Change in Marginal Cost Leading to Tariff Increase

σ	Calibrated Pre-shock Marginal Cost (c_3^{-1})	Marginal Cost After Shock (c_3^0)	Percent Change From Period 1 to Period 2 ($(c_3^0 - c_3^{-1})/c_3^{-1}$)
2	0.3663	0.4800	31.05%
2.25	0.4309	0.5357	24.33%

Table 6 shows optimal tariff rates under differing assumptions about the political economy weights. Optimal tariff rates are highest when the government's political economy motive extends to all domestic production, including the local affiliate firm. This is demonstrated in the final column in Table 6, where the government values the welfare of the domestic firm $1/a^c = 10.7$ times more than the rest of social welfare and it values local affiliate production $1.5a^c/a^c = 1.5$ times more than the rest of social welfare.[12]

For the set of parameters outlined in Table 1, the large exporting firm (firm 2) always chooses to tariff jump and the small exporting firms do not tariff jump. The calibrated value of a that fits the model for each combination of σ and ω, denoted a^c, is presented in Table 6. For comparison, the table also includes the tariff level for the social welfare maximizing

[12] The sensitivity of the model solution to parameter choices arises again here with the choice of ψ. The optimal tariff becomes too large when $\psi = 1$ for the model to find a solution. Given the current setup of the model, keeping ψ relatively close to a^c is the only way to ensure the model will solve.

Table 6: Calibrated Political Economy Weights and Optimal Tariffs

			No Political Economy ($a = 1$, $\psi = 1$)		Political Economy: Shock-Receiving Firm Only ($a = a^c$, $\psi = a^c$)		Political Economy: All Domestic Production ($a = a^c$, $\psi = 1.5\, a^c$)	
σ	ω	Tariff Jump?	a^c	τ_1^{Opt}	a^c	τ_1^{Opt}	a^c	τ_1^{Opt}
2	0.3	True	—	0.317	0.0851	1.188	0.0935	1.523
2	0.5	True	—	0.525	0.0851	3.140	0.0935	5.934
2.25	0.3	True	—	0.446	0.1115	1.066	0.1257	1.353
2.25	0.5	True	—	0.748	0.1115	2.614	0.1257	4.125

version of the model (the column labeled "No Political Economy" in the table).

Table 7 shows how the tariff increase affects the market share of each type of firm in the domestic industry when the political economy weight is placed on the domestic firm only. Table 8 shows how the tariff increase effects the market share of each type of firm in the domestic industry when the political economy weight is placed on all domestic firms in the industry. The direction of the changes in market shares are the same as in Section 3.2: the large exporting firm increases market share after changing modes of supply, and the domestic firm increases market share in period 2 after the tariff increase is implemented and the firm lowers their marginal costs. The effect in the second period of the model is the same for each simulation. This reflects the fact that in period 2, the domestic firm returns to its original marginal cost (which is the same for both versions of the political economy model) and returns to the original tariff level (which is also the same for both political economy versions of the model).

The effect of the optimal tariff on prices, quantities, and each part of the government welfare equation are available in the appendix in Tables 11 and 12 for the case when the government only places additional political economy weight on the domestic firm only. The same tables are available for the simulation in which the government places political economy

Table 7: Effect of Tariff Increase on Market Share, Political Economy Weight on Shock-Receiving Firm Only, Percent Change Compared to Period 0

	σ=2 ω=0.3 a=0.0851 ψ=1	σ=2 ω=0.5 a=0.0851 ψ=1	σ=2.25 ω=0.3 a=0.1115 ψ=1	σ=2.25 ω=0.5 a=0.1115 ψ=1
Period 1 percent change in home market share:				
Local Affiliate	-45.67	30.64	-67.36	17.85
Large Exporter (after tariff jump)	268.6	209.9	319.5	243.3
Domestic Firm	-12.8	6.635	-18.37	3.378
Small Exporter	-59.04	-70.42	-66.19	-75.62
Period 2 percent change in home market share:				
Local Affiliate	-89.13	-52.42	-113.2	-63.65
Large Exporter (after tariff jump)	216.9	129.	262.2	158.8
Domestic Firm	12.86	26.78	30.2	16.87
Small Exporter	-31.72	-19.51	-39.68	-23.95

Table 8: Effect of Tariff Increase on Market Share, Political Economy Weight on All Domestic Production, Percent Change Compared to Period 0

	σ=2 ω=0.3 a=0.0935 ψ=1.5 a	σ=2 ω=0.5 a=0.0935 ψ=1.5 a	σ=2.25 ω=0.3 a=0.1257 ψ=1.5 a	σ=2.25 ω=0.5 a=0.1257 ψ=1.5 a
Period 1 percent change in home market share:				
Local Affiliate	-39.59	45.61	-61.68	28.41
Large Exporter (after tariff jump)	275.6	224.7	326.1	254.1
Domestic Firm	-11.34	10.85	-17.02	6.407
Small Exporter	-63.43	-80.75	-70.32	-83.03
Period 2 percent change in home market share:				
Local Affiliate	-89.13	-52.42	-113.2	-63.65
Large Exporter (after tariff jump)	216.9	129.0	262.2	158.8
Domestic Firm	12.86	26.78	30.2	16.87
Small Exporter	-31.72	-19.51	-39.68	-23.95

weight on all firms producing domestically (Tables 13 and 14).

4 Conclusion

In this paper we solve for the optimal tariff rate following a negative shock to domestic production, showing that increasing the tariff rate can both benefit domestic firms as they recover from a shock and encourage FDI through foreign affiliate production. The temporary optimal tariff benefits the domestic producer and tariff-jumping firm, and reduces the market share of firms that continue to export. The inclusion of a calibrated political economy parameter increases the size of the optimal tariff rates, as the government places less importance on the negative effects to consumer surplus and other welfare components. A series of illustrative simulations show how these results change for different parameter values.

There are some limitations to our approach. First, the model uses a simple bounding method to determine FDI changes by comparing profitability during the high-tariff period and the period after the tariff returns to its initial value. The model does not include long-term profitability after the high-tariff period ends. While this simple approach was chosen to overcome typical FDI data challenges, it may not be realistic for industries with substantial fixed entry costs.

Second, we do not attempt to model underlying changes in domestic firm competitiveness (like technology improvements, etc.) as a result of the tariff increase. This is exogenous in the model. Third, we implicitly assume that the exporting and FDI firms come from countries with similar wage profiles, because they all share the same relative wage parameter. Future versions of this model could include firm-specific relative wage parameters. Finally, domestic firm exports are not directly modeled or included in the welfare calculation, implying that they are unaffected by the temporary tariff increase as a simplifying assumption.

Finally, the model considers the tariff level that will both protect domestic producers following a shock and lead exporting firms to invest locally. It would be interesting to instead build the model from the perspective of the firm that receives the shock to its marginal cost, and explore optimal decision making when deciding whether or not to pursue increased tariff protection.

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A Additional Tables of Results

The effect of the increased tariff level on prices, quantities, and each of the government welfare components is reported in this section for each of the three simulations:

- **Simulation 1:** there is no political economy weight placed on the welfare of the industry;
- **Simulation 2:** the government only places political economy weight on the welfare of the shock-receiving firm;
- **Simulation 3:** the government places political economy weight on the welfare of all domestic-producing firms in the sector.

Table 9: Simulation 1 Results: Percent Changes Compared to Period 0

	σ=2 ω=0.3	σ=2 ω=0.5	σ=2.25 ω=0.3	σ=2.25 ω=0.5
Optimal tariff	0.317	0.525	0.446	0.748
Tariff jump?	True	True	True	True
Period 1 percent change in consumer price:				
p_{11}^1 (local affiliate)	-6.456	-1.965	-6.844	-1.566
p_{12}^1 (large exporter)	-66.75	-48.89	-65.03	-47.27
p_{13}^1 (domestic firm)	-0.9942	-0.2974	-1.059	-0.2388
p_{14}^1 (small exporter)	20.14	39.03	31.3	58.48
Period 1 percent change in home consumption:				
q_{11}^1 (local affiliate)	-14.47	-3.732	-18.08	-3.382
q_{12}^1 (large exporter)	577.2	254.2	642.6	293.5
q_{13}^1 (domestic firm)	-23.64	-6.925	-28.47	-6.25
q_{14}^1 (small exporter)	-49.61	-53.33	-63.53	-68.1
Period 2 percent change in consumer price:				
p_{11}^2 (local affiliate)	-7.835	-4.878	-8.748	-5.314
p_{12}^2 (large exporter)	-67.52	-50.33	-66.46	-49.52
p_{13}^2 (domestic firm)	-23.96	-23.48	-31.64	-19.53
p_{14}^2 (small exporter)	-1.214	-0.7464	-1.362	-0.8184
Period 2 percent change in home consumption:				
q_{11}^2 (local affiliate)	-303.9	-179.	-331.3	-194.4
q_{12}^2 (large exporter)	651.1	368.5	695.1	415.4
q_{13}^2 (domestic firm)	-37.68	4.673	-26.22	-7.452
q_{14}^2 (small exporter)	-61.91	-38.84	-67.52	-42.71

Table 10: Simulation 1 Results: Percent Change in Expected Welfare for Periods 1 and 2 of Imposing the Optimal Tariff Compared to Continuing with τ_0.

	σ=2 ω=0.3	σ=2 ω=0.5	σ=2.25 ω=0.3	σ=2.25 ω=0.5
Government Welfare	301.8	195.4	-387.1	-253.8
Consumer Surplus	-82.13	-34.21	-53.98	-20.27
Producer Surplus	-33.68	-27.42	-31.32	-25.62
Tariff Revenue	-19.72	12.82	-22.72	7.693

Table 11: Simulation 2 Results: Percent Changes Compared to Period 0

	σ=2 ω=0.3 a=0.08512	σ=2 ω=0.5 a=0.08512	σ=2.25 ω=0.3 a=0.1115	σ=2.25 ω=0.5 a=0.1115
Optimal tariff	1.188	3.140	1.066	2.614
Tariff jump?	True	True	True	True
Period 1 percent change in consumer price:				
p^1_{11} (local affiliate)	-4.839	3.066	-6.124	1.501
p^1_{12} (large exporter)	-65.38	-46.1	-63.88	-45.05
p^1_{13} (domestic firm)	-0.7325	0.4524	-0.9357	0.2254
p^1_{14} (small exporter)	93.7	262.	82.99	216.8
Period 1 percent change in home consumption:				
q^1_{11} (local affiliate)	-9.173	4.351	-14.19	2.598
q^1_{12} (large exporter)	586.2	281.5	635.8	308.
q^1_{13} (domestic firm)	-16.53	9.852	-23.97	5.559
q^1_{14} (small exporter)	-79.61	-92.24	-82.33	-92.79
Period 2 percent change in consumer price:				
p^2_{11} (local affiliate)	-8.483	-5.33	-9.434	-5.792
p^2_{12} (large exporter)	-67.41	-50.23	-66.35	-49.41
p^2_{13} (domestic firm)	-24.02	-23.52	-31.71	-19.58
p^2_{14} (small exporter)	-2.019	-1.255	-2.256	-1.373
Period 2 percent change in home consumption:				
q^2_{11} (local affiliate)	-18.49	-10.29	-24.98	-13.24
q^2_{12} (large exporter)	542.7	224.6	596.2	251.4
q^2_{13} (domestic firm)	18.26	37.46	41.62	23.87
q^2_{14} (small exporter)	-31.5	-19.33	-39.58	-23.88

Table 12: Simulation 2 Results: Percent Change in Expected Welfare for Periods 1 and 2 of Imposing the Optimal Tariff Compared to Continuing with τ_0.

	σ=2. ω=0.3 a=0.08512	σ=2. ω=0.5 a=0.08512	σ=2.25 ω=0.3 a=0.1115	σ=2.25 ω=0.5 a=0.1115
Government Welfare	-79.11	-79.63	-80.3	-82.1
Consumer Surplus	-78.9	-28.89	-57.08	-22.34
Producer Surplus	50.77	86.96	19.47	52.74
Tariff Revenue	-0.4631	2.327	-20.35	-16.39

Table 13: Simulation 3 Results: Percent Changes Compared to Period 0

	σ=2 ω=0.3 a=0.0935	σ=2 ω=0.5 a=0.0935	σ=2.25 ω=0.3 a=0.1257	σ=2.25 ω=0.5 a=0.1257
Optimal tariff	1.523	5.934	1.353	4.125
Tariff jump?	True	True	True	True
Period 1 percent change in consumer price:				
p^1_{11} (local affiliate)	-4.273	4.99	-5.667	2.686
p^1_{12} (large exporter)	-65.06	-45.15	-63.54	-44.34
p^1_{13} (domestic firm)	-0.6455	0.7323	-0.8647	0.4026
p^1_{14} (small exporter)	122.4	500.7	107.6	346.5
Period 1 percent change in home consumption:				
q^1_{11} (local affiliate)	-7.929	6.615	-12.89	4.453
q^1_{12} (large exporter)	591.2	290.6	639.3	314.3
q^1_{13} (domestic firm)	-14.53	15.82	-22.1	9.874
q^1_{14} (small exporter)	-84.22	-97.05	-86.43	-96.55
Period 2 percent change in consumer price:				
p^2_{11} (local affiliate)	-8.483	-5.33	-9.434	-5.792
p^2_{12} (large exporter)	-67.41	-50.23	-66.35	-49.41
p^2_{13} (domestic firm)	-24.02	-23.52	-31.71	-19.58
p^2_{14} (small exporter)	-2.019	-1.255	-2.256	-1.373
Period 2 percent change in home consumption:				
q^2_{11} (local affiliate)	-18.49	-10.29	-24.98	-13.24
q^2_{12} (large exporter)	542.7	224.6	596.2	251.4
q^2_{13} (domestic firm)	18.26	37.46	41.62	23.87
q^2_{14} (small exporter)	-31.5	-19.33	-39.58	-23.88

Table 14: Simulation 3 Results: Percent Change in Expected Welfare for Periods 1 and 2 of Imposing the Optimal Tariff Compared to Continuing with τ_0.

	σ=2. ω=0.3 a=0.0935	σ=2. ω=0.5 a=0.0935	σ=2.25 ω=0.3 a=0.1257	σ=2.25 ω=0.5 a=0.1257
Government Welfare	-75.64	-75.69	-75.48	-76.62
Consumer Surplus	-76.03	-23.25	-55.51	-20.03
Producer Surplus	66.47	110.4	34.4	73.82
Tariff Revenue	-1.666	-20.09	-22.29	-31.47