Discussion Paper, Series A, No.2019-342

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10.2019

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Abstract

The paper aims to characterize the tariff policy for final goods as well as for intermediate inputs in the model of heterogeneous firms. We developed a theoretical model to show how the tariff on final goods and intermediate inputs affect the welfare, productivity, and the entry of firms in a country. We formulate the tariff level selection choice available to the policymaker with respect to four policy experiments. These policy experiments include; unilateral tariff selection, cooperative tariff selection, non-cooperative tariff selection, and political tariff selection. Our results show that at the Stackelberg equilibrium, which results from the unilateral tariff selection, the policy level selected by the leader is higher compared to the rest of the experiments. While, in the case of cooperation, free trade will be the equilibrium outcome. Since, the welfare gains of one country come at the cost of others, therefore, zero tariffs are the optimal strategy for both countries. At Nash equilibrium, which results of non-cooperative tariff policy selection, both countries select policy level simultaneously and applied positive tariff rates for both intermediate inputs and final goods. Lastly, at political equilibrium, which results after considering lobby by the heterogeneous firms, the policy level selection diverges from benchmark unilateral level. To illustrate our tariff policy formulations quantitively, we use the US import data to estimate the policy levels. These estimates are then compared the factual tariff rates to evaluate the degree of political interference of lobbying firms in the policy level selection.

Keywords: intermediate inputs; heterogeneous firms; trade policy; lobbying firms

JEL Classification: F12, F13, D72

1. Introduction

The recent trade pattern indicates the dominance of the intermediate inputs trade.[1] Analogous to the trade of final goods, trade of intermediate inputs also administers through trade barriers. In this regard, the most preferable trade barrier for the sake of protection is the import tariff (Staiger and Tabellini 1987). However, the presence of intermediate inputs tariff wipes out the conventionally perceived advantages of the final goods tariff (Ruffin 1969). Therefore, the gains from trade are more contingent on intermediate inputs tariff than final goods tariff.[2] Against this backdrop, the paper intends to characterize the intermediate inputs tariff in the model of heterogeneous firms along with final goods tariff. We develop a theoretical model of heterogeneous firms to show how the tariff on intermediate inputs and final goods affect the welfare, productivity, and entry of firms in a country. We also formulate the tariff level selection choice available to the policymaker with respect to four policy experiments. These policy experiments include; unilateral tariff selection, cooperative tariff selection, non-cooperative tariff selection, and political tariff selection.

We develop a model of two-country two-sector with quasi-linear preferences, where one sector produces homogenous good and other produce differentiated goods. The production of differentiated good requires the acquisition of intermediate inputs along with labor. The heterogeneous firms that produce differentiated goods can also employ imported intermediate inputs along with domestic intermediate inputs. However, cross-border trade involves the transport cost and import tariffs. Our primary focus is on the description of import tariff on intermediate inputs and final goods. in this regard, we explore the tariff policy option available to the policymaker. We first describe the unilateral tariff implementation by one country in order to maximize its own welfare and act as a leader in the Stackelberg tariff selection game. Then, we illustrate the situation in which both countries collaborate with each other and select the efficient level of tariff rate that maximizes the joint welfare. At the third step, we discussed the situation of a non-cooperative tariff policy selection, where both countries select policy level simultaneously. This non-cooperative policy game offers the Nash equilibrium policy outcome. Lastly, we explore the possibility of lobbying by the heterogeneous firms, and the implications of the lobby on the tariff policy outcome that results in political equilibrium. In order to quantify our policy experiments and to validate our tariff characterizations, we use US trade statistics to estimates the elasticity of substitution and elasticity import demand with respect to the tariff. These estimates provide us a quantitative illustration of tariff levels.

Caliendo et al. (2017) presents a similar type of model and quantify the welfare impacts of Uruguay Round, preferential agreements, and free trade. They primarily focus on the entry effect of the tariff reduction and asserts that even if the reduction in tariff deteriorates the terms-of-trade of the country, still the movement of the entry towards the optimal level increases welfare. Therefore,

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[1] See Shrestha (215), Antras and Helpman (2004).

[2] As indicated by the empirical evidences, for example, the productivity gains are twice for intermediate inputs tariff reduction compare to final goods tariff reduction in case of Indonesia (Amiti and Konings 2007), and a quarter of productivity growth attributed to intermediate inputs trade liberalization for Hungry (Halpern et al. 2015). Dardis (1967) also bears similar results for German agriculture sector. For the product variety gains of intermediate inputs tariff reduction, see Goldberg et al. (2010).

liberalization is always welfare enhancing. Our model differs from this study in terms of framework and scope. We focused on quasi-linear preferences in order to get a neat presentation of consumer welfare and then articulate the tariff selection. In the case of homogeneous firms, Ossa (2014) studies the welfare implications of implementing the optimal tariff, non-cooperative tariff, and cooperative tariff. The study indicates that the welfare gains of one country at the expense of other countries are possible in case of the optimal/unilateral tariff, but not in the event of the non-cooperative tariff. Moreover, cooperative tariff brings significant welfare gains for all countries, like WTO negotiations. Another study by Kasahara and Lapham (2008) also develops a stochastic heterogeneous firms model for Chilean manufacturing industry. They demonstrate that the usage of imported intermediate inputs increases the productivity of the firms and large firms mostly participate in import/export business. Therefore, the importing intermediate inputs can also be an important channel of resource allocation, like exporting channel. The study by Bagwell and Lee (2018) is also related, which characterizes the tariff rates of final goods in the event of unilateral, cooperative, and non-cooperative policy selection. However, the trade of intermediate inputs and input-output linkage of production is missing in both Ossa (2014) and Bagwell and Lee (2018). While, Chakraborty (2003) formalize asymmetric countries model in which the intermediate inputs are export by capital-rich countries and final goods by labor-rich countries. In this asymmetric settings, he assessed the distributional effects of trade liberalization. The study by Demidova and Rodriguez-Clare (2009) consider the case of a small open economy in the standard Melitz model and assert that in the presence of markup and entry distortions, the optimal policy to achieve the first best allocation is either import tariff or export tax in case of final goods trade. Another study by Felbermayr et al. (2013) focuses on the terms-of-trade rationale for final good tariffs and elaborates the role of relative market size. This article extends the analysis of intermediate inputs and final goods tariff policy in the heterogeneous firms model and contributes in three respects. First, we formulate the role of intermediate inputs trade policy on productivity and welfare with quasi-linear preference. By unfolding the channel through which tariff policy affect the total factor productivity makes the relationship between productivities of domestic and foreign firms operating in a market more perceptible. Secondly, the extent to which tariff policy effected by lobbies has also been explored in the case of heterogeneous firms. We analyze changes in policy level selection cause by lobbying activities of intermediate inputs importing and final good exporting firms. Lastly, we illustrate the equilibrium outcomes that can be resulted in case of different tariff policy experiments, for example, in the case of unilateral tariff selection, the Stackelberg equilibrium has been portrayed.

Our results show that in the event of unilateral tariff selection, the leader will have the first mover advantage and policy level selected by the follower will be lower than the leader for intermediate inputs. The follower either adopt the policy of a positive tariff rate or provision of a subsidy if allowed. However, the reaction of the follower depends critically upon the elasticity of substitution between the intermediate inputs. But, in the case of final goods tariff selection, the follower will select a higher tariff rate compared to the leader. While in the event of cooperation, free trade will be the equilibrium outcome. Since, the welfare gains of one country come at the cost of others,

therefore, zero tariff is the optimal strategy for both countries. Comparatively, in the event of non-cooperation and when both countries move simultaneously to impose a tariff. Then, both countries select positive tariff level at this symmetric Nash equilibrium. In the event of political tariff selection, the selection of a lower tariff level compare to benchmark-unilateral level highlights the role played by lobbying firms. However, the extent of the role of lobby depends upon the degree of the benevolence of the policymaker. In our last step, we measure the elasticities required for quantification of tariff formulations by using trade data of US for the period of 2000-2006. Then, we use factual data of the US tariffs on intermediate input and final goods to compare our estimates. The result of the comparison between factual tariffs and estimated tariffs describes that the policymaker assigns three times more weight to social welfare than political contributions.

The rest of the paper is organized as follow. Section 2 describes the basic setup of the model and also holds the discussion about the impact of the tariff on welfare and productivity. Section 3 characterizes the tariff selection in case of four policy experiments. Section 4 presents a quantitative illustration on the tariff level selection in case of previously described policy experiments. Section 5 concludes.

2. The Model

Consider a two-country two-sector model, where one sector produces freely traded homogeneous good under perfect competition. While, the other sector produces differentiated goods under monopolistic competition. The differentiated good producing sector has a continuum of heterogeneous firms and each firm produces a different variety of the final good, as in Melitz (2003). The production of differentiated goods involves labor and intermediate inputs. The intermediate inputs are produced by a continuum of firms with the constant return to scale technology. The final good producing firms can employ either domestic or both domestic and imported intermediate inputs in the production process. Both home country i and foreign country j have similar economic structure except with respect to the trade policy level.

2.1. Households

The representative household derives utility from the consumption of homogeneous goods Q_o and the differentiated goods Q, and supply labor inelastically. The total population in one country provides L hours of labor. The preferences in the home country i are given by;[3]

$$U_i = Q_0 + \frac{1}{\theta}\left(\int_{\omega\in\Omega_n}(q_{ni}(\omega))^{(\sigma-1)/\sigma}d\omega\right)^{\frac{\theta\sigma}{(\sigma-1)}}, \quad \sigma > 1, n \in \{i,j\} \qquad (1)$$

where Q_o is the consumption of numeraire good, and ω is the particular variety that belongs to the set of continuum horizontally differentiated goods Ω_n. The elasticity of substitution between the different varieties is given by $\sigma > 1$, and $\theta \in (0,1)$ measures the substitution between the consumption of homogenous good and differentiated goods. Given the total spending Y and price of a variety ω denoted by $p(\omega)$, the above utility function generates the following demand of variety ω of differentiated good imported from foreign country j in home country i as;

$$q_{ji}(\omega) = P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}} p_{ji}(\omega)^{-\sigma} \qquad (2)$$

[3] see Helpman and Itskhoki (2010) and Bagwell and Lee (2018) for the usage of this type of utility function.

where P_i is the ideal price index and given by;

$$P_i = \left[\int_{\omega \in \Omega_n} p_{ni}(\omega)^{1-\sigma}\, d\omega\right]^{\frac{1}{1-\sigma}}, n \in \{i, j\} \quad (3)$$

2.2. Final Goods Producing Firms

The homogeneous good production technology requires only labor as input. This sector is perfectly competitive with the unit input-output coefficient. Furthermore, the homogeneous good trades freely and serves as the numeraire in the model. While, differentiated final good producing firms are monopolistically competitive, and each firm is producing one particular variety of the differentiated final good. The production of differentiated final goods involves intermediate inputs along with labor. The heterogeneous firm can use domestic as well as imported intermediate inputs. The technology in differentiated final good producing sector exhibit increasing returns to scale along with the free entry. This sector is our main focus in the rest of the discussion.

The entry in the differentiated sector requires a fixed entry cost f_i^e. After incurring this entry cost, the final producing firm draws productivity φ_i from the cumulative productivity distribution $G(\varphi)$. Besides the fixed entry cost, the production process also involves an overhead cost f_{ii} and a cross-border market access cost f_{ij}. Hence, the total fixed cost of a differentiated final good producing firm in home country i that employ imported intermediate inputs from foreign country j and also export final good is given by;

$$F_i(z) = f_{ii} + z f_{ij} \quad (4)$$

where $z \in \{0,1\}$ indicates the decision of the differentiated final good producing firm to engage in foreign trade, with $z = 0$ implies that the firm does not engage in import/export. The production function of the differentiated final good is;

$$q_i(\varphi_i, z) = \varphi_i l_i^{\alpha} \left[\int_0^1 x_{ii}(s)^{\frac{\gamma-1}{\gamma}}\, ds + z \int_0^1 x_{ji}(s)^{\frac{\gamma-1}{\gamma}}\, ds\right]^{\frac{\gamma(1-\alpha)}{\gamma-1}} \quad (5)$$

with $\gamma > 1$ as the elasticity of substitution between any two intermediate inputs. While l_i is labor input with share $0 < \alpha < 1$, $x_{ii}(s)$ is the domestic variety of intermediate inputs and $x_{ji}(s)$ is the imported variety of intermediate inputs. To simplify the analysis, we fixed the measure of intermediate inputs produced in one country at one.

2.3. Intermediate Input Suppliers

In the intermediate inputs production sector, the entry and access to the blueprint of production technology are free. The continuum intermediate good producing firms are identical and produced only with labor under perfect competition. The underlying constant return to scale technology is identical for all suppliers and marginal productivity of labor is one. These considerations allow the domestic price for the intermediate good to set equal to one.

However, there are two types of trade frictions exist in cross-border intermediate inputs trade. The first friction presents in the form of iceberg type transport cost. Resultantly, $\tau_{ji} > 1$ units of an intermediate input required to be imported from foreign country j in order to receive one unit in home country i. The second trade friction considered here is the import tariff. The home country i imposes an import tariff t_{ji} on all varieties of intermediate imported inputs and $\tilde{t}_{ji}$ on the import

of final goods. Therefore, the price of intermediate input imported in the home country i will be $t_{ji}\tau_{ji}$. In this regard, we assume the trade policy selection precedes the firms' entry decision.

Cost Minimization: To simplify the analysis, let's assume that the final good producing firm chooses the same level of employment of all intermediate input varieties. The solution of the cost minimization problem of the final good producing firm from home country i yields following conditional factor demand and variable cost function;

$$x_{ii}(\varphi_i, z) = \frac{q_i(\varphi_i)}{\varphi_i}\left(\frac{(1-\alpha)}{\alpha}\right)^{\alpha}\left[1 + z\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{\alpha-\gamma}{(\gamma-1)}}$$

$$x_{ji}(\varphi_i, z) = \frac{q_i(\varphi_i)}{\varphi_i}\left(\frac{(1-\alpha)}{\alpha}\right)^{\alpha}\left(t_{ji}\tau_{ji}\right)^{-\gamma}\left[1 + z\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{\alpha-\gamma}{(\gamma-1)}}$$

$$l_i(\varphi_i, z) = \frac{q_i(\varphi_i)}{\varphi_i}\left(\frac{(1-\alpha)}{\alpha}\right)^{\alpha-1}\left[1 + z\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{(\alpha-1)}{(\gamma-1)}}$$

$$C_i(\varphi_i, z) = \frac{q_i(\varphi_i)}{\varphi_i}(1-\alpha)^{\alpha-1}(\alpha)^{-\alpha}\left[1 + z\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{(\alpha-1)}{(\gamma-1)}} \quad (6)$$

However, by applying duality we can write the production function as;

$$q_i(\varphi_i, z) = A_i(\varphi_i, z) l_i^{\alpha}\left[x_{ii} + z\left(t_{ji}\tau_{ji}\right)x_{ji}\right]^{1-\alpha} \quad (7)$$

where;

$$A_i(\varphi_i, z) = \varphi_i \zeta_i^z, \text{ with } \zeta_i^z = \left[1 + \mathrm{z}\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{1-\alpha}{(\gamma-1)}}$$

The term $A_i(\varphi_i, z)$ measures the total factor productivity. This expression, as emphasizes by Kasahara and Lapham (2008), also shows the final good producing firm that employs imported intermediate inputs has higher productivity compared to the firm that employs only domestic intermediate inputs, since $A_i(\varphi_i, 0) < A_i(\varphi_i, 1)$.

Profit Maximization: By considering fixed cost in equation (4) and variable cost in equation (6), the optimal domestic pricing rule for the final good producing firm will be;

$$p_{ii}\left(\varphi_{ij}, z\right) = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{1}{A_i\left(\varphi_{ij}, z\right)\Gamma}\right) \quad (8)$$

where $\Gamma = \alpha^{\alpha}(1-\alpha)^{1-\alpha}$. While, the price charged at foreign market incorporate transport cost τ_{ij} and tariff $\tilde{t}_{ij}$. The optimal pricing rule at foreign market j changed by the final good producer from home country i will be;

$$p_{ij}(\varphi) = \tau_{ij}\tilde{t}_{ij}p_{ii}\left(\varphi_{ij}, z\right)$$

The domestic and foreign revenue of the differentiated final good producing firm from the home country that also participate in import/export will be:

$$R_{ii}\left(\varphi_{ij}, z\right) = P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\left(\frac{\sigma-1}{\sigma}\right)A_i\left(\varphi_{ij}, z\right)\Gamma\right)^{\sigma-1}$$

$$R_{ij}\left(\varphi_{ij}, z\right) = \tau_{ij}{}^{1-\sigma}\tilde{t}_{ij}{}^{-\sigma}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\left(\frac{\sigma-1}{\sigma}\right)A_i\left(\varphi_{ij}, z\right)\Gamma\right)^{\sigma-1} \quad (9)$$

2.4.Exit, Export/Imports Decision of a firm

The differentiated final good producing firm's decisions; either to produce or quit the market, produce with only domestic intermediate inputs or with imported intermediate inputs as well, export the final product or not, depend upon the productivity level of the firm. For the sake of

simplicity, we assume only two types of heterogeneous firms in both countries. The first type consists of those firms that produce with domestic intermediate inputs and sell in the domestic market only. The second type of firms include firms that produce with both domestic and imported intermediate inputs and also export final good to other country. The threshold productivity level of a firm from home country i to produce final goods with imported intermediate inputs and sell in the foreign market can be determined by utilizing zero-profit condition. The zero-profit condition will read;

$$\tau_{ij}{}^{1-\sigma}\tilde{t}_{ij}{}^{-\sigma}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\left(\frac{\sigma-1}{\sigma}\right)A_i(\varphi_{ij},z)\Gamma\right)^{\sigma-1}=\sigma(f_{ii}+zf_{ij}) \qquad (10)$$

The above condition gives the cutoff productivity, φ_{ij}^*, of final good producer from home country i with import/export engagement. Besides this productivity cutoff, there is the productivity level for producing with domestic inputs and selling at the domestic market φ_{ii}^*. More explicitly, these productivities cutoffs are given as;

$$\varphi_{ij}^*=\tilde{t}_{ij}{}^{\frac{\sigma}{\sigma-1}}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ij}}{\zeta_i\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma(f_{ii}+zf_{ij})\right)^{1-\sigma}$$

$$\varphi_{ii}^*=P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{1}{\Gamma}\left(\frac{\sigma}{\sigma-1}\right)(\sigma f_{ii})^{1-\sigma} \qquad (11)$$

The associated fixed costs of production dictates $\varphi_{ii}^*<\varphi_{ij}^*$. Hence;

- The firm with the productivity level $\varphi<\varphi_{ii}^*$ will quit the market right after the realization of the productivity level after paying the fixed entry cost f_i^e.
- The firms with productivity level $\varphi_{ii}^*\leq\varphi<\varphi_{ij}^*$ will decide to produce with domestic intermediate input and serve the domestic market only.
- While the firms with productivity level $\varphi_{ij}^*\leq\varphi$ will export the final product to foreign country and produce with imported intermediate inputs.

The total mass of active firms M_i in home country is $[1-G(\varphi_i)]M_i^e$, where the potential entrants are denoted by M_i^e. The cumulative productivity distribution function $G(\varphi_i)$ is assumed Pareto with shape parameter β and $\beta>\sigma-1$. Therefore, $G(\varphi_i)=1-\left(\frac{\underline{\varphi}}{\varphi}\right)^{\beta}$. Hence, the mass of firms producing with imported inputs will be, $M_{ij}=m_{ij}M_i$, where $m_{ij}=\frac{1-G(\varphi_{ij})}{1-G(\varphi_{ii})}=\left(\frac{\varphi_{ii}}{\varphi_{ij}}\right)^{\beta}$ is the import/export participation rate.

The expected profit of a final good producing firm by serving the foreign country market is,

$$\bar{\pi}_{ij}(\varphi_{ij},z)=(\psi-1)(f_{ii}+zf_{ij}) \qquad (12)$$

where $\psi={\beta}/{(\beta-\sigma+1)}$. Therefore, the free entry condition reads;

$$(\psi-1)(2f_{ii}+zf_{ij})(\varphi_{ii})^{-\beta}=f_i^e\underline{\varphi}^{-\beta} \qquad (13)$$

By considering the mass of firms and productivity cutoff, the price index in the equation (3) can be transformed as;

$$P_i^{1-\sigma}=\psi M_i\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}(\Gamma\varphi_{ii}^*)^{\sigma-1}+\psi\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\sum_{\substack{n,n'\in\{i,j\}\\ n\neq n'}}m_{nn'}M_n\left(\frac{\zeta_n^z\Gamma\varphi_{nn'}^*}{\tau_{ni}\tilde{t}_{ni}}\right)^{\sigma-1} \qquad (14)$$

As all the costs present in the form of per unit labor cost. Therefore, we can use the labor market clearing condition to determine the equilibrium mass of firms active in the home country. The mass of firms in a country is given by the following equation;

$$M_i = L_i\left(\frac{(\psi-1)\underline{\varphi}^{\beta}\left(\varphi_{ii}^{*}\right)^{-\beta}}{\sigma\psi f_i^e}\right) \tag{15}$$

The above equation along with free entry condition can also determine the mass of potential entrants $\left(M_i^e = \frac{L_i(\psi-1)}{\sigma\psi f_i^e}\right)$ in the economy.

2.5. Total Revenue and Welfare

The total expenditures on imported intermediate inputs and on the imported final goods in the home country i can be expressed as;

$$E_i^{int} = m_{ij}M_i\left(t_{ji}\tau_{ji}\right)\bar{x}_{ji}$$
$$E_i^{final} = m_{ji}M_j\tilde{t}_{ji}\bar{R}_{ji}$$

Therefore, the net tariff revenue will be;

$$TR_i = \left(t_{ji}-1\right)m_{ij}M_i\tau_{ji}\bar{x}_{ji} + (\tilde{t}_{ji}-1)m_{ji}M_j\bar{R}_{ji} \tag{16}$$

Given the quasi-linear utility function, the welfare per worker in home country will be,

$$W_i = 1 + TR_i + \frac{1-\theta}{\theta}P_i^{-\frac{\theta}{1-\theta}} \tag{17}$$

Proposition-1: The consumer surplus depends negatively on both intermediate inputs and final goods tariffs. Therefore, a tariff reduction either on intermediate inputs or final good increases the consumer surplus;

$$\frac{\partial CS_i}{\partial t_{ji}}, \frac{\partial CS_i}{\partial \tilde{t}_{ji}} < 0$$

Proof: From equation (20), we know that $CS = \frac{1-\theta}{\theta}P^{-\frac{\theta}{1-\theta}}$. Hence,

$$\frac{\partial CS_i}{\partial t_{ji}} = -P_i^{-\frac{1}{1-\theta}}\frac{\partial P_i}{\partial t_{ji}}$$
$$\frac{\partial CS_i}{\partial \tilde{t}_{ji}} = -P_i^{-\frac{1}{1-\theta}}\frac{\partial P_i}{\partial \tilde{t}_{ji}}$$

The last term in the equations, change in the price index due to change in tariff, is positive. This positive relationship is partly because of the increase in average productivity in the market due to tariff reduction. A reduction in tariff increases the mass of firms engage in import/export and decreases the mass of domestic firms, which leads to an increase in the average productivity in the market. Since, price is inversely related to the productivity of the firm, therefore, prices will fall with a fall of the tariff. The same phenomenon will happen in the foreign market as well.

Next, we characterize the equilibrium tariff rates for the intermediate inputs and final goods in case of four scenarios. In this regard, we start with sequential tariff rate selection and then move to simultaneous selection.

3.1. Stackelberg Equilibrium Tariff

First, we consider the case of sequential tariff selection in which one country moves first and select the policy levels without the fear of retaliation from another country. Therefore, the country that moves first maximizes her own welfare without considering the reaction of the other country. In

this sequential tariff level selection, we assume home country i acts as leader and foreign country j as the follower.[4] Since, the welfare is comprised producer surplus (which is zero due to free entry condition), consumer surplus, and tariff revenue. Therefore, the maximization problems of the home country (leader) i is;

$$\max_{\tilde{t}_{ji},t_{ji}} W_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}\left(\tilde{t}_{ji},t_{ji}\right),t_{ij}\left(\tilde{t}_{ji},t_{ji}\right)\right) = 1 + CS_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}\left(\tilde{t}_{ji},t_{ji}\right),t_{ij}\left(\tilde{t}_{ji},t_{ji}\right)\right) + TR_i\left(\tilde{t}_{ji},t_{ji}\right)$$

However, the policymaker of the foreign country, which acts as follower, solves following maximization problem;

$$\max_{\tilde{t}_{ij},t_{ij}} W_j\left(\bar{\tilde{t}}_{ji},\bar{t}_{ji},\tilde{t}_{ij},t_{ij}\right) = CS_j\left(\bar{\tilde{t}}_{ji},\bar{t}_{ji},\tilde{t}_{ij},t_{ij}\right) + TR_j\left(\tilde{t}_{ij},t_{ij}\right)$$

$$s.t.$$

$$IM_j^{int} - EX_j^{int} = m_{ji}M_jt_{ij}\tau_{ij}\bar{x}_{ij} - m_{ij}M_it_{ji}\tau_{ji}\bar{x}_{ji} = 0$$

$$IM_j^{final} - EX_j^{final} = m_{ij}M_i\tilde{t}_{ij}\bar{R}_{ij} - m_{ji}M_j\tilde{t}_{ji}\bar{R}_{ji} = 0$$

where IM stands for imports and EX stands for exports. With $f_{ii} = f_{jj}$ and $\tau_{ij} = \tau_{ji} = \tau$, the tariff rates selected by foreign country (follower) for intermediate inputs and final goods are given by (see appendix);

$$t_{ij}^{SB} = \frac{(t_{ji})\left(\frac{\sigma-1}{\sigma}\right)^{\gamma-1}}{\left((t_{ij}-1)^{\gamma-1}\left(1+(t_{ji}\tau)\right)-(t_{ji}\tau)\left(\frac{\sigma-1}{\sigma}\right)^{\gamma-1}\right)}$$

$$\tilde{t}_{ij}^{SB} = \left(\frac{1}{\sigma-1}\right)^{1/2}\tilde{t}_{ji}{}^{1/2}$$

Now, from the unconstraint maximization problem of the leader, the tariff rates selected by the home country are given as;

$$t_{ji}^{SB} = \frac{\varsigma(\sigma-1)+\sigma}{\varsigma(\sigma-1)+1}$$

$$\tilde{t}_{ji}^{SB} = \frac{\beta}{\beta-1}$$

where $\left(-\varsigma = \frac{\partial\bar{x}_{ji}}{\partial t_{ji}^*}\frac{t_{ji}^*}{\bar{x}_{ji}}\right)$ is the elasticity of import demand with respect to tariff.

Proposition-2: Consider the above described Stackelberg unilateral tariff equilibrium and suppose $\gamma = 2$. Then the tariff rate selected by the follower will always be lower than the leader in case of intermediate inputs. If we allow the case of negative tariff (subsidy), then the retaliation options available to follower also include the possibility to select negative tariff rate. However, the tariff rate of final goods will be higher than the leader.

Proof: see the quantitative illustration section.

3.2. Cooperative/Efficient Equilibrium Tariff

Now, we assume cooperation among countries related to tariff level selection. Since, the welfare of each country depends upon own tariff policy and foreign tariff policy. Therefore, in the case of cooperation between the countries, both countries will maximize the joint welfare AW;

$$AW\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij},t_{ij}\right) = W_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij},t_{ij}\right) + W_j\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij},t_{ij}\right)$$

$$AW\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij},t_{ij}\right) = 2 + CS_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij},t_{ij}\right) + TR_i\left(\tilde{t}_{ji},t_{ji}\right) + CS_j\left(\tilde{t}_{ij},t_{ij},\tilde{t}_{ji},t_{ji}\right) + TR_j\left(\tilde{t}_{ij},t_{ij}\right)$$

[4] For timing of trade policy selection and endogenous selection of leader and follower, see Supasri (2007).

The first order conditions entail;

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial t_{ji}}=\left(\frac{m_{ji}M_jt_{ij}\tau_{ij}\bar{x}_{ij}}{t_{ji}^2}\left(\left(t_{ji}-1\right)\varsigma-1\right)-\frac{\left(t_{ij}-1\right)}{t_{ij}}\left(m_{ij}M_i\tau_{ji}\bar{x}_{ji}m_{ij}+M_it_{ji}\tau_{ji}\frac{\partial\bar{x}_{ji}}{\partial t_{ji}}\right)\right)$$

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial t_{ij}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial t_{ji}}=\left(\frac{m_{ij}M_it_{ji}\tau_{ji}\bar{x}_{ji}}{t_{ij}^2}\left(\left(t_{ij}-1\right)\varsigma-1\right)-\frac{\left(t_{ji}-1\right)}{t_{ji}}\left(m_{ji}M_j\tau_{ij}\bar{x}_{ij}+m_{ji}M_jt_{ij}\tau_{ij}\frac{\partial\bar{x}_{ij}}{\partial t_{ij}}\right)\right)$$

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial \tilde{t}_{ji}}=-\left(\frac{m_{ij}M_i\tilde{t}_{ij}\bar{R}_{ij}}{\tilde{t}_{ji}^2}+\frac{\left(\tilde{t}_{ij}-1\right)}{\tilde{t}_{ij}}\left(m_{ji}M_j\bar{R}_{ji}+m_{ji}M_j\tilde{t}_{ji}\frac{\partial\bar{R}_{ji}}{\partial\tilde{t}_{ji}}\right)\right)$$

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ij}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial \tilde{t}_{ij}}=-\left(\frac{m_{ji}M_j\tilde{t}_{ji}\bar{R}_{ji}}{\tilde{t}_{ij}^2}+\frac{\left(\tilde{t}_{ji}-1\right)}{\tilde{t}_{ji}}\left(m_{ij}M_i\bar{R}_{ij}+m_{ij}M_i\tilde{t}_{ij}\frac{\partial\bar{R}_{ij}}{\partial\tilde{t}_{ij}}\right)\right)$$

By applying symmetry assumption and trade balance conditions, we end up with;

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial t_{ji}}=\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial t_{ij}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial t_{ji}}$$

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial \tilde{t}_{ji}}=\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ij}}+\frac{\partial CS_j}{\partial P_j}\frac{\partial P_j}{\partial \tilde{t}_{ij}}$$

The Proposition-1 indicates that the change in consumer surplus is negatively related to the change in the tariff rate. The imposition of a positive tariff by either country causes a fall in the joint welfare. Therefore, the cooperative tariff rates selected by both countries will be zero. Furthermore, as argued by Caliendo et al. (2017), the imposition of a positive tariff by either country reduces the entry and this reduction in entry causes a contraction of output and raises the price level. However, the tariff redistribution unable to offset entry reduction effect entirely. Therefore, free trade will be the outcome in the event of cooperation.

$$t_{ji}^E=t_{ij}^E=0$$

$$\tilde{t}_{ji}^E=\tilde{t}_{ij}^E=0$$

3.3. Non-Cooperative/Nash Equilibrium Tariff

Next, we formulate tariff selection in case of non-cooperation among countries. The difference of this policy experiment from the first case is that here each country set the tariff rates keeping in mind the retaliation from the other country. Both countries move simultaneously and select tariff levels in a non-cooperative manner. The Nash equilibrium is the outcome of this policy experiment and policymaker in each country solves the following problem;

$$\max_{\tilde{t}_{n'n},\,t_{n'n}} W_n=1+\ CS_n(\tilde{t}_{n'n},t_{n'n},\tilde{t}_{nn'},t_{nn'})+TR_n(\tilde{t}_{n'n},t_{n'n})\,,nn'\in\{i.j\},n\neq n'$$

$s.t.$

$$IM_n^{int}-EX_n^{int}=m_{nn'}M_nt_{n'n}\tau_{n'n}\bar{x}_{n'n}-m_{n'n}M_{n'}t_{nn'}\tau_{nn'}\bar{x}_{nn'}=0,nn'\in\{i.j\},n\neq n'$$

$$IM_n^{final}-EX_n^{final}=m_{n'n}M_{n'}\tilde{t}_{n'n}\bar{R}_{n'n}-m_{nn'}M_n\tilde{t}_{nn'}\bar{R}_{nn'}=0,nn'\in\{i.j\},n\neq n'$$

The first order conditions are;

$$\frac{\partial W_n}{\partial t_{n'n}}=\frac{\partial CS_n}{\partial t_{n'n}}+\frac{t_{n'n}\left((t_{n'n}-1)m_{n'n}M_{n'}t_{nn'}\tau_{nn'}\frac{\partial\bar{x}_{nn'}}{\partial t_{n'n}}+m_{n'n}M_{n'}t_{nn'}\tau_{nn'}\bar{x}_{nn'}\right)-(t_{n'n}-1)m_{n'n}M_{n'}t_{nn'}\tau_{nn'}\bar{x}_{nn'}}{t_{n'n}^2}=0,nn'\in\{i.j\},n\neq n'$$

$$\frac{\partial W_n}{\partial \tilde{t}_{n'n}}=\frac{\partial CS_n}{\partial \tilde{t}_{n'n}}+\frac{\tilde{t}_{n'n}\left((\tilde{t}_{n'n}-1)m_{nn'}M_n\tilde{t}_{nn'}\frac{\partial\bar{R}_{nn'}}{\partial\tilde{t}_{n'n}}+m_{nn'}M_n\tilde{t}_{nn'}\bar{R}_{nn'}\right)-(\tilde{t}_{n'n}-1)m_{nn'}M_n\tilde{t}_{nn'}\bar{R}_{nn'}}{\tilde{t}_{n'n}^2}=0,nn'\in\{i.j\},n\neq n'$$

As we are seeking for symmetric Nash equilibrium[5], therefore, $t_{n'n} = t_{nn'} = t$ and $\tilde{t}_{n'n} = \tilde{t}_{nn'} = \tilde{t}$. The application of symmetry assumption gives following equilibrium tariff level;

$$t^N = \frac{\varsigma(\sigma-1)+2\sigma-1}{\varsigma(\sigma-1)+\sigma}$$
$$\tilde{t}^N = \frac{\sigma\beta+\sigma-1}{\sigma\beta-1}$$

3.4. Political Equilibrium Tariff

Finally, we depict the case when the tariff selection process can be influenced by lobbying firms. Therefore, here we allow the participation in the lobby by the heterogeneous firms in order to make the policymaker to select a lower tariff level compare to the unilateral tariff level.[6] The lobbying firms offer monetary benefits to the policymaker in response to the change of policy level selection. We assume lobbying possibility only exist in home country i and call the tariff level selected by policymaker at the home country i after lobby as the political tariff rate. We not only allow participation in lobbying activities by domestic firms but also by foreign firms as well.[7] To articulate this political economy of tariff policy, we utilize the Grossman and Helpman (1994) "protection for sale (PFS)" framework. In order to proceed, assuming the policymaker in the home country i is willing to accept the political contribution $C(t_{ji})$ offered by the import/export participating firms. So, these political contributions appear along with fixed costs $f_{ii} + zf_{ij}$ in the profit function of the heterogeneous firms.

Firm's Objective Function: The objective functions of the firm from home country i and from foreign country j are given as;

$$V_i(t_{ji}, C) = \hat{\pi}_i(t_{ji}, \tilde{t}_{ij}) - C(t_{ji})$$
$$V_j(\tilde{t}_{ji}, C) = \hat{\pi}_{ji}(\tilde{t}_{ij}) - C(\tilde{t}_{ij})$$

where $\hat{\pi}_i(t_{ji}, \tilde{t}_{ij}) = \hat{\pi}_{ii}(t_{ji}) + \hat{\pi}_{ij}(t_{ji}, \tilde{t}_{ij})$ is the operating profit of the firm. The political contributions are assumed to be;

Assumption-1: The political contribution schedule is differentiable, at least around the equilibrium.

Assumption-2: The political contribution schedules are truthful, that is, given the welfare scalar B;

$$C(t_{ji}) = \max\{0, \hat{\pi}_i(t_{ji}, \tilde{t}_{ij}) - B\}$$
$$C(\tilde{t}_{ji}) = \max\{0, \hat{\pi}_{ji}(\tilde{t}_{ji}) - B\}$$

Policymaker's Objective Function: the utility function of the policymaker depends upon the social welfare and political contributions. The political contribution is positively related to the utility level of the policymaker. Thus, the single peaked preferences of the policymaker with respect to trade policy T_i, with $(t_{ji}, \tilde{t}_{ij} \in T_i)$ can be represented by the following utility function;

$$\mathfrak{U}_i(T_i, C) = aW_i(T_i) + \sum_{\substack{n,n' \in \{i,j\} \\ n \neq n'}} m_{nn'} M_n C(T_i)$$

[5] Ogawa (2012) has identified the condition of symmetric price elasticity of numeraire good across all nonnumeraire for a uniform Nash tariff rate in the case of two countries. He has also characterized the case when this conditions do not satisfy.

[6] For endogenous lobby formation see Mitra (1999) and in case of heterogeneous firms see Bombardini (2008).

[7] See Gawande et al. (2006) and Stoyanov (2009) for foreign firms lobbying participation in the case of US.

where $a \in (0,1)$ is the weight that assigned to social welfare. This weight also indicates the degree of the benevolence of the policymaker, higher the policymaker valued social welfare, higher will be the value of the coefficient a. Following the PFS framework, the conditions below describe the equilibrium tariff level on the intermediate inputs and final goods that will be selected by the policymaker (see appendix);

$$a\frac{\partial W_i(T_i)}{\partial t_{ji}} + m_{ij}M_i\frac{\partial \hat{\pi}_i(T_i)}{\partial t_{ji}} = 0$$
$$a\frac{\partial W_i(T_i)}{\partial \tilde{t}_{ji}} + m_{ji}M_j\frac{\partial \hat{\pi}_{ji}(T_i)}{\partial \tilde{t}_{ji}} = 0$$

Therefore, the equilibrium tariff levels given by the above conditions are;

$$t_{ji}^P = \frac{a(\varsigma(\sigma-1)+\sigma)+(\sigma-\beta-1)}{(a\varsigma+1)(\sigma-1)+a}$$
$$\tilde{t}_{ji}^p = \frac{\beta(a\sigma-1)}{a\sigma(\beta-1)}$$

Proposition-3: Consider the above described policy experiments, the unilateral tariff rate will be highest compare to non-cooperative and political rates, and

$$\frac{\partial t^{SB}}{\partial \sigma} > 0, \frac{\partial t^N}{\partial \sigma} > 0, \frac{\partial t_{ji}^P}{\partial \sigma} > 0 \qquad \frac{\partial \tilde{t}_{ji}{}^{SB}}{\partial \sigma} = 0, \frac{\partial \tilde{t}_{ii}{}^{SB}}{\partial \sigma} < 0, \frac{\partial \tilde{t}^N}{\partial \sigma} < 0, \frac{\partial \tilde{t}_{ji}^P}{\partial \sigma} > 0$$
$$\frac{\partial t^{SB}}{\partial \varsigma} < 0, \frac{\partial t^N}{\partial \varsigma} < 0, \frac{\partial t_{ji}^P}{\partial \varsigma} < 0 \qquad \frac{\partial \tilde{t}^{SB}}{\partial \varsigma} = \frac{\partial \tilde{t}^N}{\partial \varsigma} = \frac{\partial \tilde{t}_{ji}^P}{\partial \varsigma} = 0$$
$$\frac{\partial t^{SB}}{\partial \beta} = \frac{\partial t^N}{\partial \beta} = 0, \frac{\partial t}{\partial \beta} < 0 \qquad \frac{\partial \tilde{t}^{SB}}{\partial \beta} = \frac{\partial \tilde{t}^N}{\partial \beta} = 0, \frac{\partial \tilde{t}_{ji}^P}{\partial \beta} < 0$$
$$\frac{\partial t^{SB}}{\partial a} = \frac{\partial t^N}{\partial a} = 0, \frac{\partial t}{\partial a} > 0 \qquad \frac{\partial \tilde{t}^{SB}}{\partial a} = \frac{\partial \tilde{t}^N}{\partial a} = 0, \frac{\partial \tilde{t}_{ji}^P}{\partial a} > 0$$

Proof: see the quantitative illustration section.

4. Quantitative Illustration

To make a comparison between these tariff formula and to elaborate on how the policy level selection differs in a different framework, consider a quantitative illustration. In all formulations, the tariff rate specification contains the elasticity of substitution of differentiated goods σ, import tariff elasticity ς, Pareto shape parameter β, and political weight. In order to measure the elasticity of substitution and import tariff elasticity, we applied Feenstra (1994) approach by using US import data for the period of 2000 to 2006. The disaggregated data at HS 10-digit code is obtained from the center for international data.[8] In order to differentiate between the trade of final goods and intermediate inputs, we use the concordance of BEC and HS.[9] Additionally, in the case of followers intermediate inputs tariff formulation, the transport cost also present and the data on the transport cost obtained from ESCAP-World Bank International Trade Cost Database. While, to obtain the estimate for the Pareto shape parameter β, we use the estimates of Bernard and Jensen (1999). Our elasticities estimation results yield $\sigma = 4.55$ and $\varsigma = 8.08$ and transport cost in case of US-Canada is around 28.5% for the period of analysis with Pareto parameters ranges from 8 to 9 as in Bernard and Jensen (1999). Given the estimates of all parameters and assuming the

[8] The data is available at https://cid.econ.ucdavis.edu/

[9] For BEC classification visit https://unstats.un.org/unsd/tradekb/Knowledgebase/Intermediate-Goods-in-Trade-Statistics, and for the concordance between BEC and HS visit https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp

elasticity of substitution between intermediate inputs $\gamma = 2$ for the sake of lucid description, the table below contains the quantitative illustration of tariff rates in case to all policy experiments.

Table I: The Tariff Rate in case of Policy Experiments

$\sigma = 4.55$	Stackelberg Equilibrium				Nash Equilibrium		Political Equilibrium	
$\varsigma = 8.08$	t_{ji}^{SB}	$\tilde{t}_{ji}^{SB}$	t_{ij}^{SB}	$\tilde{t}_{ij}^{SB}$	t^{N}	$\tilde{t}^{N}$	t_{ji}^{P}	$\tilde{t}_{ji}^{p}$
$\beta = 8.50$								
$a = 2.85$	1.11	1.12	1.10	1.18	1.1068	1.1139	1.0178	1.0426
$\tau = .280$								

The most prominent feature in the above table is that the tariff rate of the final goods is higher than the tariff on intermediate goods in all specifications. We assume the political weight equal to 2.85 in order to match our estimates with the factual data. The factual data on the tariff rates of intermediate inputs and final consumption goods for the US is collected from the World Bank's World Integrated Trade Solution (WITS) for the years 2000-2006. We treated the MFN applied tariff rates on intermediate inputs and final consumption goods as the political tariff rate that results from the political equilibrium. For the period of analysis, the weighted average political tariff rate for the intermediate good is 1.88 and in case of final goods is 4.33. While, our estimation with political weight equal to 2.85 indicates the intermediate input tariff equal to 1.78 and final good tariff equal to 4.26, which are very close to the factual data.

The tariff rates are dependent on the variations of the parameters. The following table contains a representation of how the tariff rates depend upon the parameters.

Table 2: Parameters and The Tariff Rates

$\boldsymbol{a}$	$\boldsymbol{\sigma}$	$\boldsymbol{\varsigma}$	$\boldsymbol{\beta}$	t^{SB}		t^{N}	t_{ji}^{P}	$\tilde{t}^{SB}$		$\tilde{t}^{N}$	$\tilde{t}_{ji}^{p}$
				t_{ji}	t_{ij}			$\tilde{t}_{ji}$	$\tilde{t}_{ij}$		
2							0.977				1.008
3	4.55	8.08	8.50	1.119	1.106	1.106	1.023	1.133	1.193	1.120	1.050
4							1.046				1.071
2							1.045				1.062
3	8.00	8.08	8.50	1.121	1.120	1.108	1.069	1.133	1.138	1.119	1.086
4							1.082				1.097
2							0.981				1.008
3	4.55	10.0	8.50	1.097	1. 088	1.086	1.019	1.133	1.193	1.120	1.050
4							1.038				1.071
2							0.953				0.989
3	4.55	8.08	10	1.119	1.106	1.106	1.007	1.111	1.176	1.102	1.029
4							1.034				1.050

The table shows that in the case of unilateral tariff intermediate tariff selection, the leader will select a tariff rate that is higher than all other policy levels. While, in the case of unilateral final goods tariff, the follower selects a higher tariff rate. Another feature is shown in the table that the political tariff rates of intermediate inputs and final good are less than the unilateral tariff rates, which indicates the role that lobbying firms have played. However, the divergence of political

tariff rate from the unilateral rate depends upon the degree of the benevolence of the policymaker. As the policymaker assign higher weights to social welfare, the political tariffs converge toward the unilateral tariff rates. Furthermore, the political tariff also depends negatively upon the productivity parameter β of the Pareto distribution. As a high value of β translates into low productivity dispersion among firms. When the productivity dispersion is low among heterogeneous firms, then tariff rate variations make the market selection more sensitive. Hence, the tariff rate will be low, if the productivity dispersion among heterogeneous firms is low.

Moreover, the elasticity of substitution between the differentiated varieties σ is positively associated in all the tariff formulation, except political final good tariff. While, the elasticity of imported intermediate inputs has a negative relationship with intermediate tariffs. As the varieties of the final differentiated good become more substitutable, the incentive to have more varieties of differentiated good that used imported inputs will reduce. Therefore, apply a higher tariff will not affect the welfare much, against the case where the elasticity of substitution of final differentiated varieties is low. On the other hand, when the demand for imported intermediate inputs is more elastic with respect to the tariff, the policymaker will select a lower tariff level.

5. Conclusion

In this study, we have analyzed the trade policy of intermediate inputs and final goods in a two-country two-sector model. The model we develop indicates that only more productive firms use imported inputs in the production process. In case of intermediate inputs; the imposition of tariff affects the welfare negatively, as it erects a trade barrier that lowers the average productivity in the market. In this regard, we focus on the channel through which the productivity gets affected by intermediate input tariff. Then, we characterize the policymaker's tariff selection process in the event of four policy experiments. First, we assume country behave unilaterally and select a tariff rate that maximizes her own welfare. The tariff level selected by the policymaker, in case of intermediate inputs, is high and the country enjoys first mover advantage. While, in the case of final goods, the follower will select a higher tariff compared to the leader. Second, the policy experiment incorporates cooperation between the countries and both countries maximize the joint welfare. The outcome of this policy experiment is free trade. In the third scenario, we consider non-cooperative simultaneous tariff selection context and characterize symmetric Nash equilibrium. In our last step, we bring the political economy of tariff policy in the discussion and allow the possibility of lobbying.

The analysis can be extended in different dimensions. One particular dimension would be the introduction of asymmetry and analysis of the distributional effects of intermediate inputs change. Another dimension to extend this analysis would be to incorporate more than two types of firms along with vertical production process.

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Appendices

Appendix-A: Stackelberg Equilibrium Tariff;

The Home Country's Case (Leader)

Intermediate Inputs Tariff: the first order conditions for home country i for the intermediate inputs tariff can be expressed explicitly as;

$$\frac{\partial CS_i(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}(\tilde{t}_{ji},t_{ji}),t_{ij}(\tilde{t}_{ji},t_{ji}))}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}} + m_{ij}M_i(t_{ji}-1)\tau_{ji}\frac{\partial \bar{x}_{ji}}{\partial t_{ji}} + m_{ij}M_i\tau_{ji}\bar{x}_{ji} = 0$$

Solving for $(t_{ji}-1)$, with defining the elasticity of import $\left(-\varsigma = \frac{\partial \bar{x}_{ji}}{\partial t_{ji}}\frac{t_{ji}}{\bar{x}_{ji}}\right)$

$$(t_{ji}-1) = \frac{t_{ji}}{\varsigma}\left(\frac{\frac{\partial CS_i(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}(\tilde{t}_{ji},t_{ji}),t_{ij}(\tilde{t}_{ji},t_{ji}))}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}}}{m_{ij}M_i\tau_{ji}\bar{x}_{ji}} + 1\right) \qquad \text{(A.I)}$$

Where;

$$m_{ij}M_i\tau_{ji}\bar{x}_{ji} = \frac{m_{ij}M_i}{1-G(\varphi_{ij})}\tau_{ji}\int_{\varphi_{ij}^*}^{\infty}\frac{q_i(\varphi_{ij},z)}{\varphi_{ij}}\left(\frac{(1-\alpha)}{\alpha}\right)^{\alpha}(t_{ji}\tau_{ji})^{-\gamma}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{\alpha-\gamma}{(\gamma-1)}}dG(\varphi_{ij})$$

$$m_{ij}M_i\tau_{ji}\bar{x}_{ji} = M_i^e P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}(1-\alpha)(\tau_{ji})^{1-\gamma}t_{ji}^{-\gamma}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(\Gamma)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1} \qquad \text{(A.II)}$$

However;

$$\frac{\partial CS_i(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}(\tilde{t}_{ji},t_{ji}),t_{ij}(\tilde{t}_{ji},t_{ji}))}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}} = -P_i^{-\frac{1}{1-\theta}}\frac{\partial P_i}{\partial t_{ji}}$$

The price index in terms of parameters of the model is given by;

$$P_i = \left[M_i^e\left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ii}^{*\,\sigma-\beta-1} + M_i^e\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1} + M_j^e(\tilde{t}_{ji}\tau_{ji})^{1-\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ij}\tau_{ij})^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\right]^{\frac{1}{1-\sigma}}$$

$$\frac{\partial P_i}{\partial t_{ji}} = \left[M_i^e\left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ii}^{*\,\sigma-\beta-1} + M_i^e\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1} + M_j^e(\tilde{t}_{ji}\tau_{ji})^{1-\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ij}\tau_{ij})^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\right]^{\frac{\sigma}{1-\sigma}}M_i^e\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}}t_{ji}^{-1}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1}\left\{(1-\alpha)(t_{ji}\tau_{ji})^{1-\gamma} + \frac{(\sigma-\beta-1)}{1-\sigma}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]\frac{\partial ln\varphi_{ij}^*}{\partial ln t_{ji}}\right\}$$ [10]

[10] By considering the Mass of importers and Pareto distribution, the zero-profit conditions are;

$$\tilde{t}_{ij}^{-\sigma}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}M_i^e\left(\left(\frac{\sigma-1}{\sigma}\right)\zeta_i\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1} = \sigma(f_{ii}+zf_{ij})$$

$$\frac{\partial P_i}{\partial t_{ji}} = \left[M_i^e\left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ii}^{*\,\sigma-\beta-1} + M_i^e\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1} + M_j^e\left(\tilde{t}_{ji}\tau_{ji}\right)^{1-\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+\left(t_{ij}\tau_{ij}\right)^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\right]^{\frac{\sigma}{1-\sigma}} M_i^e\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}} t_{ji}^{-1}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1}(1-\alpha)(t^h-1)$$

Hence;

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}} = -M_i^e P_i^{\frac{\sigma(1-\theta)-1}{1-\theta}}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*\,\sigma-\beta-1}t_{ji}^{-\gamma-1}\tau_{ji}^{1-\gamma}(1-\alpha)(t^h-1) \qquad \text{(A.III)}$$

By plugging equation (A.III) and (A.II) into (A.I)

$$\left(t_{ji}-1\right) = \frac{t_{ji}}{\varsigma}\left(-\frac{\sigma\left(t_{ji}-1\right)}{t_{ji}(\sigma-1)}+1\right)$$

$$t_{ji} = \frac{\varsigma(\sigma-1)+\sigma}{(\varsigma(\sigma-1)+1)}$$

Final Goods Tariff: the first order condition with respect to final goods tariff can also be expressed as;

$$\frac{\partial CS_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}\left(\tilde{t}_{ji},t_{ji}\right),t_{ij}\left(\tilde{t}_{ji},t_{ji}\right)\right)}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}} + m_{ji}M_j\left(\tilde{t}_{ji}-1\right)\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}} + m_{ji}M_j\bar{R}_{ji} = 0$$

Which gives;

$$\left(\tilde{t}_{ji}-1\right) = -\frac{\frac{\partial CS_i\left(\tilde{t}_{ji},t_{ji},\tilde{t}_{ij}\left(\tilde{t}_{ji},t_{ji}\right),t_{ij}\left(\tilde{t}_{ji},t_{ji}\right)\right)}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}}}{m_{ji}M_j\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}}} - \frac{m_{ji}M_j\bar{R}_{ji}}{m_{ji}M_j\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}}} \qquad \text{(A.IV)}$$

Where;

$$m_{ji}M_j\bar{R}_{ji} = M_j^e\tilde{t}_{ji}^{-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta_j\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1} \qquad \text{(A.V)}$$

$$m_{ji}M_j\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}} = M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta_j\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-\sigma+(\sigma-\beta-1)\frac{\partial ln\varphi_{ji}^*}{\partial ln\tilde{t}_{ji}}\right)^{11}$$

$$P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}M_j^e\left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{jj}^{*\,\sigma-\beta-1} = \sigma f_{jj}$$

From the ratio of conditions;

$$\varphi_{ij}^* = \left(\left(\tilde{t}_{ij}\right)^{\sigma}\left(\frac{\sigma\left(f_{ii}+zf_{ij}\right)}{\sigma f_{jj}}\right)\frac{M_j^e}{M_i^e}\right)^{\frac{1}{\sigma-\beta-1}}\varphi_{jj}^*\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]^{\frac{(1-\alpha)(1-\sigma)}{(\gamma-1)(\sigma-\beta-1)}}$$

$$ln\varphi_{ij}^* = lnD + \frac{(1-\alpha)(1-\sigma)}{(\gamma-1)(\sigma-\beta-1)}ln\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]$$

$$\frac{\partial ln\varphi_{ij}^*}{\partial lnt_{ji}^*} = -\frac{(1-\alpha)(1-\sigma)}{(\sigma-\beta-1)}\frac{\tau_{ji}^{1-\gamma}t_{ji}^{-\gamma}}{\left[1+\left(t_{ji}\tau_{ji}\right)^{1-\gamma}\right]}$$

[11] As the productivity cutoffs are;

$$\varphi_{ji}^* = \tilde{t}_{ji}^{\frac{\sigma}{\sigma-1}}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ji}}{\zeta_j\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma\left(f_{jj}+zf_{ji}\right)\right)^{1-\sigma}$$

$$\varphi_{ii}^* = P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{1}{\Gamma}\left(\frac{\sigma}{\sigma-1}\right)(\sigma f_{ii})^{1-\sigma}$$

In terms of ratio

$$\varphi_{ji}^* = \tilde{t}_{ji}^{\frac{\sigma}{\sigma-1}}\frac{\tau_{ji}}{\zeta_j}\left(\frac{\left(f_{jj}+zf_{ji}\right)}{f_{ii}}\right)^{1-\sigma}\varphi_{ii}^*$$

$$\frac{\partial ln\varphi_{ji}^*}{\partial ln\tilde{t}_{ji}^*} = \frac{\sigma}{\sigma-1}$$

$$m_{ji}M_j\frac{\partial\bar{R}_{ji}}{\partial\tilde{t}_{ji}} = M_j^e\tilde{t}_{ji}{}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta_j\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*}{}^{\sigma-\beta-1}\left(-\frac{\sigma\beta}{\sigma-1}\right) \qquad \text{(A.VI)}$$

$$\frac{\partial CS_i}{\partial P_i}\frac{\partial P_i}{\partial\tilde{t}_{ji}^{*}} = -M_j^eP_i^{\frac{\sigma(1-\theta)-1}{1-\theta}}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\zeta_j{}^{\sigma-1}(\tau_{ji})^{1-\sigma}\tilde{t}_{ji}^{-\sigma}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*}{}^{\sigma-\beta-1}\left(\frac{1}{1-\sigma}\right) \qquad \text{(A.VII)}$$

By plugging A.V-A.VII into A.IV, we will have;

$$(\tilde{t}_{ji}-1) = \frac{\tilde{t}_{ji}}{\sigma\beta}+\frac{\tilde{t}_{ji}(\sigma-1)}{\sigma\beta}$$

$$\tilde{t}_{ji} = \frac{\beta}{\beta-1}$$

Foreign Country's Case (Follower)

Intermediate Inputs Tariff: the first order condition will be;

$$\frac{\partial CS_j(\overline{\tilde{t}_{ji}},\overline{t_{ji}},\tilde{t}_{ij},t_{ij})}{\partial P_j}\frac{\partial P_j}{\partial t_{ij}} + \frac{m_{ij}M_it_{ji}\tau_{ji}\bar{x}_{ji}}{(t_{ij})^2} = 0$$

By using the analogy of equation (A.II) and (A.III);

$$M_j^eP_j^{\frac{\sigma(1-\theta)-1}{1-\theta}}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\left[1+(t_{ij}\tau_{ij})^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*}{}^{\sigma-\beta-1}t_{ij}{}^{-\gamma-1}\tau_{ij}{}^{1-\gamma}(1-\alpha)(t_{ij}-1) = \frac{M_i^eP_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}(1-\alpha)(t_{ji}\tau_{ji})^{1-\gamma}\left[1+(t_{ji}\tau_{ji})^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(\Gamma)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ij}^{*}{}^{\sigma-\beta-1}}{t_{ij}^2}$$

By using the definition of the productivity cutoffs and $f_{ii} = f_{jj}$ and $\tau_{ij} = \tau_{ji}$;

$$\frac{t_{ij}{}^{1-\gamma}(t_{ij}-1)}{1+(t_{ij}\tau)^{1-\gamma}} = \frac{\left(\frac{\sigma-1}{\sigma}\right)t_{ji}{}^{1-\gamma}}{1+(t_{ji}\tau)^{1-\gamma}}$$

Which gives;

$$t_{ij} = \frac{(t_{ji})\left(\frac{\sigma-1}{\sigma}\right)^{\gamma-1}}{\left((t_{ij}-1)^{\gamma-1}\left(1+(t_{ji}\tau)\right)-(t_{ji}\tau)\left(\frac{\sigma-1}{\sigma}\right)^{\gamma-1}\right)}$$

The final goods Tariff: The first order condition is given as;

$$\frac{\partial CS_j(\overline{\tilde{t}_{ji}},\overline{t_{ji}},\tilde{t}_{ij},t_{ij})}{\partial P_j}\frac{\partial P_j}{\partial\tilde{t}_{ij}} + \frac{m_{ji}M_j\tilde{t}_{ji}\bar{R}_{ji}}{\tilde{t}_{ij}^2} = 0$$

$$P_j^{\frac{\sigma(1-\theta)-1}{1-\theta}}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\zeta_i^{\sigma-1}(\tau_{ij})^{1-\sigma}\tilde{t}_{ij}^{2-\sigma}\varphi_{ij}^{*}{}^{\sigma-1}\left(\frac{1}{1-\sigma}\right) = \tilde{t}_{ji}{}^{1-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta_j\Gamma\right)^{\sigma-1}\varphi_{ji}^{*}{}^{\sigma-1}$$

$$P_j^{\frac{\sigma(1-\theta)-1}{1-\theta}}\zeta_i^{\sigma-1}\tilde{t}_{ij}^{2-\sigma}\varphi_{ij}^{*}{}^{\sigma-1}\left(\frac{1}{1-\sigma}\right) = \tilde{t}_{ji}{}^{1-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\zeta_j^{\sigma-1}\varphi_{ji}^{*}{}^{\sigma-1}$$

$$\varphi_{ij}^{*} = \tilde{t}_{ij}{}^{\frac{\sigma}{\sigma-1}}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ij}}{\zeta_i\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma\left(f_{ii}+zf_{ij}\right)\right)^{1-\sigma}$$

$$\varphi_{ji}^{*} = \tilde{t}_{ji}{}^{\frac{\sigma}{\sigma-1}}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ji}}{\zeta_j\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma\left(f_{jj}+zf_{ji}\right)\right)^{1-\sigma}$$

$$P_j^{\frac{\sigma(1-\theta)-1}{1-\theta}}\zeta_i^{\sigma-1}\tilde{t}_{ij}^{2-\sigma}\left(\tilde{t}_{ij}{}^{\frac{\sigma}{\sigma-1}}P_j^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ji}}{\zeta_i\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma\left(f_{ii}+zf_{ij}\right)\right)^{1-\sigma}\right)^{\sigma-1}\left(\frac{1}{1-\sigma}\right) = \tilde{t}_{ji}{}^{1-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\zeta_j^{\sigma-1}\left(\tilde{t}_{ji}{}^{\frac{\sigma}{\sigma-1}}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)(1-\sigma)}}\frac{\tau_{ji}}{\zeta_j\Gamma}\left(\frac{\sigma}{\sigma-1}\right)\left(\sigma\left(f_{jj}+zf_{ji}\right)\right)^{1-\sigma}\right)^{\sigma-1}$$

$$\tilde{t}_{ij}^2\left(\frac{1}{1-\sigma}\right) = \tilde{t}_{ji}$$

$$\tilde{t}_{ij} = \left(\frac{1}{\sigma-1}\right)^{\frac{1}{2}}\tilde{t}_{ji}{}^{\frac{1}{2}}$$

<u>Appendix-B:</u> **<u>Non-Cooperative/Nash Equilibrium Tariff;</u>**

Nash Tariff Rate

$$\max_{\tilde{t}_{n'n},\,t_{n'n}} W_n = 1 + CS_n(\tilde{t}_{n'n},t_{n'n},\tilde{t}_{nn'},t_{nn'}) + TR_n(\tilde{t}_{n'n},t_{n'n}),\, nn' \in \{i.j\}, n \neq n'$$

$$s.t.$$

$$IM_n^{int} - EX_n^{int} = m_{nn'}M_nt_{n'n}\tau_{n'n}\bar{x}_{n'n} - m_{n'n}M_{n'}t_{nn'}\tau_{nn'}\bar{x}_{nn'} = 0, nn' \in \{i.j\}, n \neq n'$$

$IM_n^{final} - EX_n^{final} = m_{n\prime n}M_{n\prime}\tilde{t}_{n\prime n}\bar{R}_{n\prime n} - m_{nn\prime}M_n\tilde{t}_{nn\prime}\bar{R}_{nn\prime} = 0, nn' \in \{i.j\}, n \neq n'$

The first order conditions are;

$$\frac{\partial W_n}{\partial t_{n\prime n}} = \frac{\partial CS_n}{\partial t_{n\prime n}} + \frac{t_{n\prime n}\left((t_{n\prime n}-1)m_{n\prime n}M_{n\prime}t_{nn\prime}\tau_{nn\prime}\frac{\partial \bar{x}_{nn\prime}}{\partial t_{n\prime n}} + m_{n\prime n}M_{n\prime}t_{nn\prime}\tau_{nn\prime}\bar{x}_{nn\prime}\right) - (t_{n\prime n}-1)m_{n\prime n}M_{n\prime}t_{nn\prime}\tau_{nn\prime}\bar{x}_{nn\prime}}{t_{n\prime n}^2} = 0, nn' \in \{i.j\}, n \neq n'$$

$$\frac{\partial W_n}{\partial \tilde{t}_{n\prime n}} = \frac{\partial CS_n}{\partial \tilde{t}_{n\prime n}} + \frac{\tilde{t}_{n\prime n}\left((\tilde{t}_{n\prime n}-1)m_{nn\prime}M_n\tilde{t}_{nn\prime}\frac{\partial \bar{R}_{nn\prime}}{\partial \tilde{t}_{n\prime n}} + m_{nn\prime}M_n\tilde{t}_{nn\prime}\bar{R}_{nn\prime}\right) - (\tilde{t}_{n\prime n}-1)m_{nn\prime}M_n\tilde{t}_{nn\prime}\bar{R}_{nn\prime}}{\tilde{t}_{n\prime n}^2} = 0, nn' \in \{i.j\}, n \neq n'$$

Symmetric Nash equilibrium, therefore, $t_{ij} = t_{ji} = t$ and $\tilde{t}_{ij} = \tilde{t}_{ji} = \tilde{t}$. Hence, $\bar{x}_{ij} = \bar{x}_{ji}$ and $\bar{R}_{ij} = \bar{R}_{ji}$

$$\frac{\partial W_i}{\partial t} = \frac{\partial CS_i}{\partial t} + \frac{t\left((t-1)m_{ij}M_i t\tau\frac{\partial \bar{x}_{ji}}{\partial t} + m_{ij}M_i t\tau\bar{x}_{ji}\right) - (t-1)m_{ij}M_i t\tau\bar{x}_{ji}}{t} = 0$$

$$\frac{\partial W_i}{\partial \tilde{t}} = \frac{\partial CS_i}{\partial \tilde{t}} + \frac{(\tilde{t}-1)m_{ji}M_j\tilde{t}\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}} + m_{ji}M_j\bar{R}_{ji}}{\tilde{t}} = 0$$

$$\frac{(t-1)m_{ij}M_i\tau\varsigma\bar{x}_{ji}}{t} = \frac{\partial CS_i}{\partial t} + \frac{m_{ij}M_i\tau\bar{x}_{ji}}{t}$$

$$(\tilde{t}-1)m_{ji}M_j\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}} = -\frac{\partial CS_i}{\partial \tilde{t}} - \frac{m_{ji}M_j\bar{R}_{ji}}{\tilde{t}}$$

$$(t-1) = \frac{t\frac{\partial CS_i}{\partial t}}{m_{ij}M_i\tau\varsigma\bar{x}_{ji}} + \frac{m_{ij}M_i\tau\bar{x}_{ji}}{m_{ij}M_i\tau\varsigma\bar{x}_{ji}} \qquad \text{B.I}$$

$$(\tilde{t}-1) = -\frac{\frac{\partial CS_i}{\partial \tilde{t}}}{m_{ji}M_j\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}}} - \frac{m_{ji}M_j\bar{R}_{ji}}{m_{ji}M_j\tilde{t}\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}}} = 0 \qquad \text{B.II}$$

By using equations, (A.II), (A.III), (A.VI), and (A.VII)

$$(t-1) = \frac{-\sigma(t-1)}{\varsigma(\sigma-1)} + \frac{1}{\varsigma}$$

$$(\tilde{t}-1) = \frac{\tilde{t}}{\sigma\beta} + \frac{(\sigma-1)}{\sigma\beta}$$

$$t = \frac{\varsigma(\sigma-1)+2\sigma-1}{\varsigma(\sigma-1)+\sigma}$$

$$\tilde{t} = \frac{\sigma\beta+\sigma-1}{\sigma\beta-1}$$

<u>Appendix-C:</u> **<u>Political Equilibrium Tariff;</u>**

(C^*, T_i^*) is the sub-game Nash equilibrium of trade policy game between policymaker and the lobbying firms if and only if;

i) C^* is feasible to all firms that employ imported intermediate inputs.

ii) T_i^* maximized $aW_i(T_i) + \sum_{\substack{n,n'\in\{i,j\}\\ n\neq n'}} m_{nn'}M_nC(T_i)$ on T_i, given $\left(t_{ji}, \tilde{t}_{ji} \in T\right)$.

iii) T_i^* maximizes $\hat{\pi}_{n\prime n}(T_i^*) - C^*(T_i^*) + aW_i(T_i^*) + \sum_{\substack{n,n'\in\{i,j\}\\ n\neq n'}} m_{nn'}M_nC^*(T_i^*)$ on T for every firm in the market i.

iv) For every firm $h \in m_{nn\prime}M_n$ in the market i there exists a $T_i^{-h} \in T_i$ that maximizes $aW_i(T_i) + \sum_{\substack{n,n'\in\{i,j\}\\ n\neq n'}} m_{nn'}M_nC^*(T_i)$ on T such that $C_h\left(T_i^{-h}\right) = 0$.

The condition (i) restricts the contribution schedule for each firm that participates in the lobby is feasible. While, condition (ii) indicates that the policymaker maximizes his own welfare given the contribution schedules offered by the lobbying firms, and (iii) states the equilibrium tariff level

must maximizes the joint welfare of both. The last condition (iv) describes that at equilibrium the policy choice may yields no political contribution and hence no lobby participation by some firms. Hence, from condition (iii) the first order condition will be;

$$\frac{\partial \hat{\pi}_{n'n}(T_i^*)}{\partial T_i^*} - \frac{\partial C^*(T_i^*)}{\partial T_i^*} + a\frac{\partial W_i(T_i^*)}{\partial T_i^*} + \sum_{\substack{n,n' \in \{i,j\} \\ n \neq n'}} m_{nn'} M_n \frac{\partial C^*(T_i^*)}{\partial T_i^*} = 0 \qquad \text{C.I}$$

However, the policymaker's maximization requires;

$$a\frac{\partial W_i(T_i^*)}{\partial T_i^*} + \sum_{\substack{n,n' \in \{i,j\} \\ n \neq n'}} m_{nn'} M_n \frac{\partial C^*(T_i^*)}{\partial T_i^*} = 0 \qquad \text{C.II}$$

Taking the above conditions together yields;

$$\frac{\partial \hat{\pi}_{n'n}(T_i^*)}{\partial T_i^*} = \frac{\partial C^*(T_i^*)}{\partial T_i^*} \qquad \text{C.III}$$

By summing over all lobbying firms and substituting (C.III) into (C.I) gives the equation that characterizes the equilibrium tariff level, which is;

$$a\frac{\partial W_i(T_i^*)}{\partial T_i^*} + \sum_{\substack{n,n' \in \{i,j\} \\ n \neq n'}} m_{nn'} M_n \frac{\partial \hat{\pi}_{n'n}(T_i^*)}{\partial T_i^*} = 0$$

More explicitly;

$$a\frac{\partial W_i(T_i)}{\partial t_{ji}} + m_{ij} M_i \frac{\partial \hat{\pi}_i(T_i)}{\partial t_{ji}} = 0 \qquad \text{C.IV}$$

$$a\frac{\partial W_i(T_i)}{\partial \tilde{t}_{ji}} + m_{ji} M_j \frac{\partial \hat{\pi}_{ji}(T_i)}{\partial \tilde{t}_{ji}} = 0 \qquad \text{C.V}$$

Intermediate Inputs Tariff: Now, consider the condition (C.IV).

$$a\left(\frac{\partial CS_i(t_{ji},\tilde{t}_{ji})}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}} + m_{ij} M_i (t_{ji} - 1)\tau_{ji}\frac{\partial \bar{x}_{ji}}{\partial t_{ji}} + m_{ij} M_i \tau_{ji}\bar{x}_{ji}\right) + m_{ij} M_i \frac{\partial \hat{\pi}_i(t_{ji})}{\partial t_{ji}} = 0$$

Solving for $(t_{ji} - 1)$;

$$(t_{ji} - 1) = \frac{t_{ji}}{\varsigma}\left(\frac{\frac{\partial CS_i(t_{ji},\tilde{t}_{ji})}{\partial P_i}\frac{\partial P_i}{\partial t_{ji}}}{m_{ij} M_i \tau_{ji}\bar{x}_{ji}} + \frac{1}{a}\frac{\frac{\partial \hat{\pi}_i(t_{ji})}{\partial t_{ji}}}{\tau_{ji}\bar{x}_{ji}} + 1\right) \qquad \text{C.VI}$$

The new term in the above equation compare to the equation in Appendix-A, is the operating profit only. Which is give in terms of parameters as;

$$\hat{\pi}_i(t_{ji}) = \frac{1}{\sigma} P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}} \left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1} \left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right]^{\frac{(1-\alpha)(\sigma-1)}{(\gamma-1)}} \psi \underline{\varphi}^{\beta} \varphi_{ij}^{*\,\sigma-\beta-1}$$

Therefore,

$$\frac{\partial \hat{\pi}_i(t_{ji})}{\partial t_{ji}} = P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}} \left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1} \left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}} \psi \varphi_{ij}^{*\,\sigma-\beta-1} t_{ji}^{-1} \left\{\frac{(1-\alpha)(1-\sigma)}{\sigma}(\tau_{ji} t_{ji})^{1-\gamma} + \frac{\sigma-\beta-1}{\sigma}\left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right]\frac{\partial ln\varphi_{ij}^*}{\partial lnt_{ji}}\right\}$$ [12]

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[12] From the productivity cutoff ratio;

$$\varphi_{ij}^* = \left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right]^{-\frac{1-\alpha}{(\gamma-1)}} \left(\frac{f_{ii} + z f_{ij} + C}{f_{jj}}\right)^{1-\sigma} \varphi_{jj}^*$$

$$ln\varphi_{ij}^* = -\frac{1-\alpha}{(\gamma-1)} ln\left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right] + lnD$$

$$\frac{\partial ln\varphi_{ij}^*}{\partial lnt_{ji}} = (1-\alpha)\frac{\tau_{ji}^{1-\gamma} t_{ji}^{-\gamma}}{\left[1 + (\tau_{ji} t_{ji})^{1-\gamma}\right]}$$

$$\frac{\partial \hat{\pi}_i(t_{ji})}{\partial t_{ji}} = P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}} \left(\left(\frac{\sigma-1}{\sigma}\right)\Gamma\right)^{\sigma-1} \left[1+\left(\tau_{ji}t_{ji}\right)^{1-\gamma}\right]^{\frac{\alpha-\gamma+\sigma(1-\alpha)}{(\gamma-1)}} \psi\varphi_{ij}^{*\,\sigma-\beta-1} t_{ji}^{-\gamma-1}\tau_{ji}^{1-\gamma}(1-\alpha)\left\{\frac{(1-\sigma)t_{ji}+\sigma-\beta-1}{\sigma}\right\} \qquad \text{C.VII}$$

Now, by plugging equation (A.III), (A.II), and (C.VII) into the equation (C.VI) yields;

$$\left(t_{ji}-1\right) = \frac{t_{ji}}{\varsigma}\left(-\frac{\left(\frac{\sigma}{\sigma-1}\right)(t_{ji}-1)}{t_{ji}} + \frac{1}{a}\frac{\left(\frac{(1-\sigma)t_{ji}+\sigma-\beta-1}{\sigma-1}\right)}{t_{ji}} + 1\right)$$

Then solve for t_{ji};

$$t_{ji}^{p} = \frac{a(\varsigma(\sigma-1)+\sigma)+(\sigma-\beta-1)}{(a\varsigma+1)(\sigma-1)+a}$$

The final goods Tariff: The condition (C.V) gives the political tariff rate of the final goods;

$$a\left(\frac{\partial CS_i(t_{ji},\tilde{t}_{ji})}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}} + m_{ji}M_j\left(\tilde{t}_{ji}-1\right)\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}} + m_{ji}M_j\bar{R}_{ji}\right) + m_{ji}M_j\frac{\partial \hat{\pi}_{ji}(\tilde{t}_{ji})}{\partial \tilde{t}_{ji}} = 0$$

$$\left(\tilde{t}_{ji}^{*}-1\right) = -\frac{\frac{\partial CS_i(t_{ji},\tilde{t}_{ji})}{\partial P_i}\frac{\partial P_i}{\partial \tilde{t}_{ji}}}{am_{ji}M_j\tau_{ji}\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}}} - \frac{m_{ji}M_j\frac{\partial \hat{\pi}_{ji}(\tilde{t}_{ji})}{\partial \tilde{t}_{ji}}}{am_{ji}M_j\tau_{ji}\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}}} - \frac{am_{ji}M_j\bar{R}_{ji}}{am_{ji}M_j\tau_{ji}\frac{\partial \bar{R}_{ji}}{\partial \tilde{t}_{ji}}} \qquad \text{C.VIII}$$

As, the operating profit function in terms of the model's parameters is;

$$\hat{\pi}_{ji}(\tilde{t}_{ji}) = \frac{1}{\sigma}M_j^e\tilde{t}_{ji}^{-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}$$

Therefore,

$$\frac{\partial \hat{\pi}_{ji}(\tilde{t}_{ji})}{\partial \tilde{t}_{ji}} = M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-1+(\sigma-\beta-1)\frac{1}{\sigma}\frac{\partial ln\varphi_{ji}^{*}}{\partial ln\tilde{t}_{ji}}\right)$$

$$\frac{\partial \hat{\pi}_{ji}(\tilde{t}_{ji})}{\partial \tilde{t}_{ji}} = M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-\frac{\beta}{\sigma-1}\right) \qquad \text{C.IX}$$

Hence,

$$\left(\tilde{t}_{ji}-1\right) = \frac{M_j^eP_i^{\frac{\sigma(1-\theta)-1}{1-\theta}}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\Gamma^{\sigma-1}\zeta^{\sigma-1}(\tau_{ji})^{1-\sigma}\tilde{t}_{ji}^{-\sigma}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(\frac{1}{1-\sigma}\right)}{M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-\frac{\sigma\beta}{\sigma-1}\right)} - \frac{M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-\frac{\beta}{\sigma-1}\right)}{aM_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(-\frac{\sigma\beta}{\sigma-1}\right)} + \frac{M_j^e\tilde{t}_{ji}^{-\sigma}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}}{M_j^e\tilde{t}_{ji}^{-\sigma-1}P_i^{\frac{\sigma(1-\theta)-1}{(1-\theta)}}\left(\tau_{ji}^{-1}\left(\frac{\sigma-1}{\sigma}\right)\zeta\Gamma\right)^{\sigma-1}\psi\underline{\varphi}^{\beta}\varphi_{ji}^{*\,\sigma-\beta-1}\left(\frac{\sigma\beta}{\sigma-1}\right)}$$

$$\left(\tilde{t}_{ji}-1\right) = \frac{\tilde{t}_{ji}}{\sigma\beta} - \frac{1}{a\sigma} + \frac{\tilde{t}_{ji}(\sigma-1)}{\sigma\beta}$$

$$\tilde{t}_{ji}^{p} = \frac{\beta(a\sigma-1)}{a\sigma(\beta-1)}$$