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Duty Inversion and Effective Protection: A Theoretical Analysis

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ABSTRACT

Indian industrialists have been complaining that the country's tariff structure has resulted in an inverted duty structure or IDS (i.e., higher tariffs on inputs compared to outputs), leading to lower profitability. Traditional trade theory uses the concept of effective rate of protection (ERP) in such a scenario. If the ERP remains positive for an industry despite IDS, then the latter may not affect the industry badly as the structure of tariff is still giving some positive protection. However, if ERP becomes negative, then industry is better off under free trade than under restricted trade. This paper makes the first attempt to check theoretically if there are any specific conditions that make tariff rates supporting IDS an optimal policy solution while maximizing a country's social welfare, even if it leads to negative ERP. We use an international oligopoly framework with two countries (home and foreign) and two vertically related goods (a final good and an intermediate input), situated in a three-stage game, to answer our research question. Depending upon various parametric configurations, our model suggests that there do exist such optimal rates of input and output tariffs that could lead to IDS in an economy, and negative ERP as well. However, this does not imply that IDS always coincides with negative ERP. In fact, we show that ERP for an industry may remain positive despite IDS, meaning thereby the latter may not adversely affect that industry because the tariff structure is still giving it protection. However, it is a completely different matter if the effective rate of protection for an industry turns out to be negative due to IDS.

Keywords: Effective rate of protection; inverted duty structure; preferential trade agreements; tariff inversion; trade policy under oligopoly.

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1. INTRODUCTION

In recent years, sections of Indian industry have been expressing concerns about the impact of an 'inverted duty structure' (hereafter IDS) resulting from changes in trade policy. In simple terms, IDS is a situation in which the tariffs on the import of raw materials/intermediate inputs for a product exceed the tariffs imposed on import of the final product. The typical complaint raised by Indian industrialists is that customs duties on the import of some products, especially from countries with which India has signed preferential trade agreements (PTAs), have fallen below the duties on the intermediate inputs required for their production. This has squeezed the profitability of the downstream producers by keeping their input costs high while exposing them to more intense foreign competition for their outputs. For instance, spokespersons of copper alloy fabricators (Iyenger, 2015), Federation of Indian Export Organizations (FIEO) (PTI, 2016b), and toy manufacturers (BS Bureau, 2016), among others, have complained about IDS. A survey by the Federation of Indian Chambers of Commerce and Industry showed that industries such as machinery, electronics, cement, rubber, minerals and textiles suffer from duty inversion (FICCI, 2016).

The issue of IDS has also been recognized by Indian policy makers. In an interaction with the journalists of *The Economic Times*, the then Finance Minister Arun Jaitley said, 'I propose to reduce the rates of basic customs duty on certain inputs, raw materials, intermediates and components (in all 22 items) so as to minimize the impact of duty inversion and reduce the manufacturing cost in several sectors' (quoted in Seth, 2015). The Tariff Commission (Government of India) also acknowledged IDS as a 'major area of constraint for domestic industries'. Thus far, it has carried out 148 studies, which cover 252 products from 2012-13 to 2018-19. It recommended duty rationalisation for 154 products, some of which were implemented in the various Budgets.[1] However, sections of Indian industry continue to complain about IDS.

In the recent 2021 budget, Finance Minister also assured that 'The thrust now has to be on easy access to raw material and exports of value added products.' (Government of India (GoI) Budget Speech 2021, Para 177). Specifically, she reduced the duties on import of input for various industries (like

[1] For the detailed list of corrections of duty inversion (as recommended by Tariff Commission) in various budgets, refer to GoI Tariff Commission (2020).

Chemicals, Iron and Steel), with specific focus on Naphtha (reduced to 2.5% to correct inversion) (GoI Budget Speech 2021, Para 182).

As far as we are award, there has been no attempt to relate the existence of IDS to the theory of optimal tariffs under imperfect competition. This paper represents a first attempt at doing so. Traditional trade theory tells us that when countries start integrating at different levels of production, then one should look at 'effective rate of protection' (ERP) rather than just comparing their nominal rates of protection. ERP concept as given by Corden (1971) and Balassa (1965), is defined as the percentage excess of the domestic value due to the imposition of tariffs and other protective measures on the product and its inputs, over the counterfactual value added under free trade. ERPs were traditionally used mainly to demonstrate how final goods producing industries benefit disproportionately from tariff escalation. But the concept of ERP can also show how protection of downstream industries can be eroded or even reversed by tariff inversion (IDS), making it relevant for our study. If ERP for an industry remains positive despite IDS, then the latter may not affect that industry too adversely, because the tariff structure is still giving it protection. This may be because the difference between input and output tariffs is small, or because the inputs that are subject to high tariffs make up a small proportion of the industry's costs. But it is a different matter if ERP for a sector is negative due to IDS. Even if it appears to be protected by a tariff on imports that compete with its output, a negative ERP shows that it may be better off under free trade.

This motivates us to examine the possibility of ERP and its co-existence with IDS, and to check theoretically whether duty inversions can result from optimal tariff structures adopted by the home and foreign governments in an oligopolistic market framework. The questions that can be raised and are of great interest to economists and policy makers are - Is there any economic rationale behind this Duty Inversion? Are there any specific conditions which make tariff rates supporting negative ERP and IDS an optimal policy solution while maximizing social welfare? Is there any relation between IDS and negative ERP?[2] Do they always co-exist? To answer these questions, we set up a theoretical partial equilibrium model in a two-country framework under oligopolistic market structure. The aim is to identify the role of various parameters that play a crucial role in determining the policy implications of the imposition of import tariffs on intermediate and final goods. In

[2] This question about the co-existence between IDS and negative ERP has been previously taken up by Corden (1971) in his study in a perfectly competitive market framework. However, we reassess this relationship in an imperfectly competitive setup with a final goods industry and an intermediate input industry.

particular, our aim is to examine whether the imposition of inverted tariffs becomes a welfare-improving policy intervention for a country's government.

The rest of the paper is organised as follows. In Section 2, we review the existing literature. In the next Section 3, we outline a basic model of optimal tariff policy with successive oligopoly, which is structured as a domestic and a foreign input producer supplying to a domestic and a foreign final goods producer. In Section 4, we solve the model and find the range of parameters under which IDS and negative ERP emerge as an optimal policy solution. Finally, in Section 5, we summarise and conclude the study.

2. **LITERATURE REVIEW**

Trade theorists and policy makers of the early twentieth century were concerned only about trade in final commodities. Their behaviour was guided by the assumption that all stages of production are carried out in the home country itself, which, in turn trades its final product with the rest of the world. As a consequence, they used to examine only the tariffs on final products while analysing the level of domestic protection accorded to specific sectors.

The review of literature suggests that Taussig (1931) was amongst the first to point out the crucial relation between intermediate inputs and final goods. There arose a need to relook at the already existing trade and tariff related policies. Both the tariffs on final goods (nominal protection) and that on intermediate inputs, became important policy instruments, more specifically with regard to their impact on domestic producers. This is primarily because, even though the tariffs on final goods provide protection to the domestic industry by allowing domestic prices to rise above the import prices, the tariffs on imports of raw materials and intermediate inputs reduce the extent of protection by raising the cost of material inputs and can be regarded as a tax on the processing of such inputs. Such combination of tariffs give rise to the notion of what is popularly referred to as the Effective Rate of Protection (ERP) in the trade literature.

Meade (1955) was among the first economists who discussed the idea of the effective rate of protection, which was empirically used by Barber (1955) in his study on the Canadian Tariff Policy. But this concept of ERP was not incorporated explicitly into trade literature till 1960's because by then the stress was on the two-commodity model and the concept of the second-best argument[3] was relatively new. The first theoretical explanation was given by Johnson (1965), which was later extended by Corden (1966) to include non-traded goods within the perfectly competitive standard trade models.

The concept of ERP refers to the protection of a process as distinct from the nominal tariffs on output (Bhagwati and Desai, 1970). Conceptually, it is defined as the percentage excess of the domestic value added due to the imposition of tariffs and other protective measures on the product and its inputs, over value added in the absence of such measure. Thus, 'while the nominal rate of protection affects the consumers' choice, the effective rate of protection indicates the effects on the processing activity of tariffs on inputs and thereby affects the producers' choices' (Balassa, 1971).

Corden (1966), in his pioneering work, explained the conceptual framework for ERP. It explained the relationship between the nominal tariff rate on a product, the nominal tariff rates on its inputs and the share of inputs in the cost of the product at free trade prices. Corden (1971) derived the concept of ERP algebraically.

ERP analysis has fallen out of favour because trade theorists showed that it fails to predict the effects of a tariff structure on inter-sectoral factor allocation in general equilibrium with more than two sectors or even with two sectors if there is substitutability between primary factors and traded intermediate inputs (Bhagwati & Srinivasan, 1973; Ethier, 1972). A strong assumption of separability must be imposed on the production function in order to avoid this problem. However, we are not interested in deriving general equilibrium results about resource allocation between sectors. In their pioneering study, Bhagwati and Desai (1970, p. 338), who were well aware of these theoretical limitations, argued that ERPs do give us a rough idea of the relative incentives given to various sectors by the foreign trade regime. Making a forceful case for the practical relevance of ERP estimation despite its theoretical shortcomings, Greenaway and Milner (2003, p. 9) pointed out that 'By highlighting potential inconsistencies or unintended effects, for example … where high nominal protection of one producer tends to disprotect other producers for which the protected

[3] 'The theory of second best in general states that in a system where conditions are such that a Pareto optimum exists, if one condition is changed so that it is no longer at its optimum state, then to reach a second best optimum (because the first best optimum cannot be reached), all the other conditions must be changed from their original first best optimum states.' – For details on the theory of second best, see Lipsey and Lancaster (1965).

product is an important input, one is able to provide a framework or basis for policy reforms'. ERPs also show how trade policy affects the value added, that is, the reward to factors employed in each sector. This might provide some insight into the political economy of trade policy. In particular, if some factors are specific to a particular sector, then even without imposing separability on the production function, changes in ERP correspond to the relative changes in returns to the specific factors (Jones & Neary, 1984, p. 33).However, after these criticism of Ramaswami and Srinivasan (1971) and Ethier (1973) who argued that this index of protection does not necessarily work in predicting output shifts, theoretical literature on effective protection did not develop any further.[4] However, here our objective is not to look at how ERP works in predicting output shift in general equilibrium. Our motive is to assess whether the optimal tariffs imposed by government support negative ERP and IDS in a partial equilibrium analysis focusing on oligopolistic competition. In addition, we also want to analyse the relation between ERP and IDS.

Further in this section, we will review some of the studies that assess a country's trade policy in an oligopoly structure and explain how that affects any country's welfare.

The review of the existing studies suggests that we can broadly categorise them into two segments – the first on one-stage (final goods stage) trade policy under oligopoly and the second on the two-stage production processes, i.e., which incorporate the role of vertically related markets. As regards the former, studies by Krugman (1983), Brander and Spencer (1984, 1985), Dixit (1984), Eaton and Grossman (1986), among others, show that under oligopoly, departures from free trade could be optimal. However, the nature of the optimal intervention crucially depends on the market structures, nature of competition, order of moves of different players, and model parameters. Similarly, Venables (1985) shows how intra-industry trade leads to an unambiguous rise in welfare by reducing the degree of monopoly power in each market. These studies represent some of the pioneer works that rely on models from Industrial Organisation to examine the optimality of different trade policies. However, what seems more relevant for addressing our questions is the second strand of literature on vertically related markets, the detailed review of which is given below.

[4] Empirical estimation of ERPs for various countries, which was a major research programme until the 1980s, also fell out of favour. Despite the relevance of the concept, there were no attempts until Pathania and Bhattacharjea (2020) to estimate ERPs for the recent period when IDS became an issue for Indian industries.

Bernhofen's 1997 study has been amongst the forerunners in this regard. He examined the impact of strategic export (tax cum subsidy) policy on Cournot duopolist final good producers (home and foreign), who buy intermediate input from a third country monopolist, and supply their final good to another country. A three-stage game structure is developed, with governments setting their trade policies in the first stage, followed by an assessment of final and intermediate input production-decisions in the second and third stages, respectively. In a similar vein, Ishikawa and Spencer (1999) have assessed the implications of intermediate input market Cournot competition on trade policy with special attention to the effects of foreign versus domestic supply. It has been shown that an export subsidy given to the final output producers leads to an increase in their profits by lowering their cost. In addition, this also entails a higher advantage for intermediate input producers as demand for final output rises due to a reduction in its price. As a consequence, if the intermediate producers are foreign firms, then the home government is less incentivized to give export subsidy to its final output producer.

Further, they have shown a contrasting result, when an extra layer of Cournot competition is introduced in the form of a purely domestic intermediate good industry. In such a case, the authors find that it becomes optimal for the government of a country to give export subsidies to its producers. This is because higher export subsidies lead to higher production efficiency due to the elimination of what is referred to as double marginalization. Alternatively, the authors examine the welfare effects of a rent shifting policy (import tariff and production subsidy) at an intermediate stage. They have shown that the combination of import tariff with production subsidy of the same amount will be equivalent to equal subsidy provided to final output producer.

McCorriston and Sheldon (2009) have also looked at the issue of how simultaneous and equivalent reduction in tariffs of both upstream and downstream imports impact the market access, and hence profit of both upstream and downstream firms in an imperfectly competitive market. To answer this question, the authors have formulated a three-stage game, where in the first stage, domestic government decides about tariffs to be charged on import of both upstream and downstream imports. The second part consists of (Cournot) Nash equilibria at upstream stage followed by the last stage where the downstream producers decide about the quantity to be supplied to different customers. While examining the effects of simultaneous reductions in tariffs on upstream and downstream imports and the relative effect on market access for both upstream and downstream producers, they found that an identical and simultaneous change in tariff imposed on imports of final and intermediate good, produces a differential effect on market access, and also on profits for each upstream and downstream domestic player. This is mainly because of combination of horizontal and vertical effect in a vertically related sector. This enables the authors to conclude that in order to ensure that the burden of trade liberalization is not biased for any upstream or downstream domestic producer, the government must ensure tariff de-escalation.

Taking the literature forward, Kawabata (2014) has compared the welfare effects of maximum revenue tariffs with optimum welfare tariffs in a vertically related model which is characterized by Cournot competition at each stage of production. In a two country framework, the author shows that if the home country's intermediate input producing firm is more competitive than the foreign country's intermediate input producing firm, then the optimum welfare tariff on the intermediate good is more than the maximum-revenue tariff. However, if the home's intermediate input firm is less efficient than the foreign country's intermediate input producing firm, then the optimum welfare tariff on the final good is more than the maximum-revenue tariff. The author further explains that in such a model set up with vertical trade structure (compared to the absence of vertical trade structure), it is not very likely for the optimum-welfare tariffs on the intermediate inputs and the final goods to exceed the maximum-revenue tariffs on the intermediate input and the final good, respectively.

In a recent study, Hwang, Mai and Wu (2017) have examined the causes of tariff escalation, i.e., when tariff rates on import of intermediate input falls short of tariffs imposed on the imports of final output, and when the former are more than those for raw materials. Assuming a vertically-related market set up with *n* stages of successive monopolies, they found that, through its effects on the prices of the upstream intermediate goods, the imposition of a tariff on an imported good can be used to extract the profit of the foreign monopolist supplying this good, as well as the rents acquired by all the foreign upstream monopolists. Thus, with an increase in the number of production stages in the foreign country, the amount of rent captured by foreign upstream producers increases. In such a case, a higher tariff rate is, therefore, needed to extract their rent. This, in turn, gives a theoretical justification for tariff escalation.

To summarise, the review of the literature suggests that 'trade under vertical structure' has been analysed theoretically in the form of a stage game, where, in stage 1, the government decides about the optimal tariff policies, followed by stage 2, in which input producers decide their quantities and, finally, in stage 3, final output producers decide on the profit-maximizing level of outputs to be supplied to various consumers. Our game structure closely follows the work done by Bernhofen (1997), Ishikawa and Spencer (1999), and McCorriston and Sheldon (2009). It is also in line with studies on the impact of domestic trade protection in vertically related markets (like Spencer and Jones (1991) and Wang et al. (2011)). In the latter set of models, the authors have assumed that the key intermediate product is being produced only by the foreign country producers and there are differences in the cost of production.

We borrow from this strand of literature. However, our primary objective is to answer the question: "Are there any specific conditions which make tariffs supporting negative ERP and IDS an optimal policy solution while maximizing social welfare?" Moreover, in our model we have assumed that the intermediate input is being produced and traded by both the countries (be it home or foreign), and no country entirely depends on the other country for its supply of final/intermediate good. We have also incorporated the role of labour, not only for producing the intermediate good but for transforming that into final output as well. Unlike the existing studies, we ensure that there do not exist any arbitrage possibilities which may affect our final solution set. Thus, our study is an extension with a wider set of objectives focusing on ERP and IDS in the absence of any arbitrage possibilities.

3. THE MODEL AND THE ASSUMPTIONS

To set up the model, we begin by assuming that there are two countries, indexed as $i \in A = \{\text{Home (H), Foreign (F)}\}$. Each country i produces two products viz. an intermediate good and a final good and contains a single producer for producing each of these products. Next, we assume that final output requires both the intermediate input and labour for production, while the production of intermediate input requires only labour. Technological relationships are simplified by assuming that only one unit of the intermediate input and one unit of labour are required to produce one unit of the final product. In this sense, both inputs are complementary to each other and cannot be substituted for each other. The same kind of relation is also assumed for the production of intermediate inputs i.e. one unit of labour is required to produce one unit of intermediate input. Thus, the production process at both levels exhibits Constant Returns to Scale. Further, the model assumes that there exists zero degree of differentiation between products (final or intermediate) produced by different countries. In other words, the output of each of the two sectors is considered as homogenous, regardless of where it is produced.

In addition, we assume that homogeneous labour comes from a perfectly competitive agricultural sector with constant returns to scale, whose product is taken as the numeraire. Labour is mobile between the two sectors within an economy, but is internationally immobile. This fixes the level of wages at W_i (for all $i \in A$) in both the sectors of country i. Producers of both the sectors (final output sector and intermediate input sector) take these wages as given and exogenous.

Further, we assume that each country's intermediate input producer gets V_i by supplying one unit of its product to the i^{th} country's final output producer, which thus becomes a part of the per unit cost of production for the latter (the other part being wage cost W_i). Thus, V_i represents the price of input in country i. This completes the description of the structure of the product and factor markets in our model.

Next, we assume that in each country i, the intermediate input producer produces r^i units of quantity and supply r_i^i (for all $i \in A$) to its own country's final output producer and r_j^i ($j \neq i$, $i,j \in A$) to the other country's final output producer. Therefore, the total quantity of input produced is equal to the total quantity of inputs supplied to its own country (i) and other country (j) i.e. $r^i = r_i^i + r_j^i$. Similarly, the final output producer in country i produces q^i and supplies q_i^i to serve its own country consumers' demand which is represented by Q_i and supplies q_j^i ($j \neq i$, $i,j \in A$) to serve the other country's consumer demand, Q_j ($j \neq i$, $i,j \in A$). This implies $q^i = q_i^i + q_j^i$. Here, the subscript represents the country where the product (be it final output or intermediate input) is demanded whereas the superscript represents the country, which is supplying the product.[5]

In country i, let's assume that the inverse demand for final output takes the following form:

$$P_i = a_i - Q_i, a_i > 0 \tag{1}$$

where P_i is the per unit price of the final output in country i, a_i is the demand intercept in country i and Q_i is the aggregate quantity demanded by consumers in country i with $P_i'(Q_i) < 0$, representing

[5] As argued by Brander (1981) and Brander and Krugman (1983), there exist reasons to expect two-way trade in identical products (final as well as intermediate) due to strategic interactions among firms.

the negative slope of the demand curve.

Lastly, to simplify our analysis, an assumption regarding the absence of transportation and other non-tariff costs has been made. This implies that the c.i.f. (cost, insurance and freight) value of import of one country is equal to its f.o.b. (free on board) value of export from the other country. On the basis of these assumptions, we set up our final model, the subgame perfect equilibrium of which incorporates three different stages of decision.

The three different stages can be briefly described as follows:

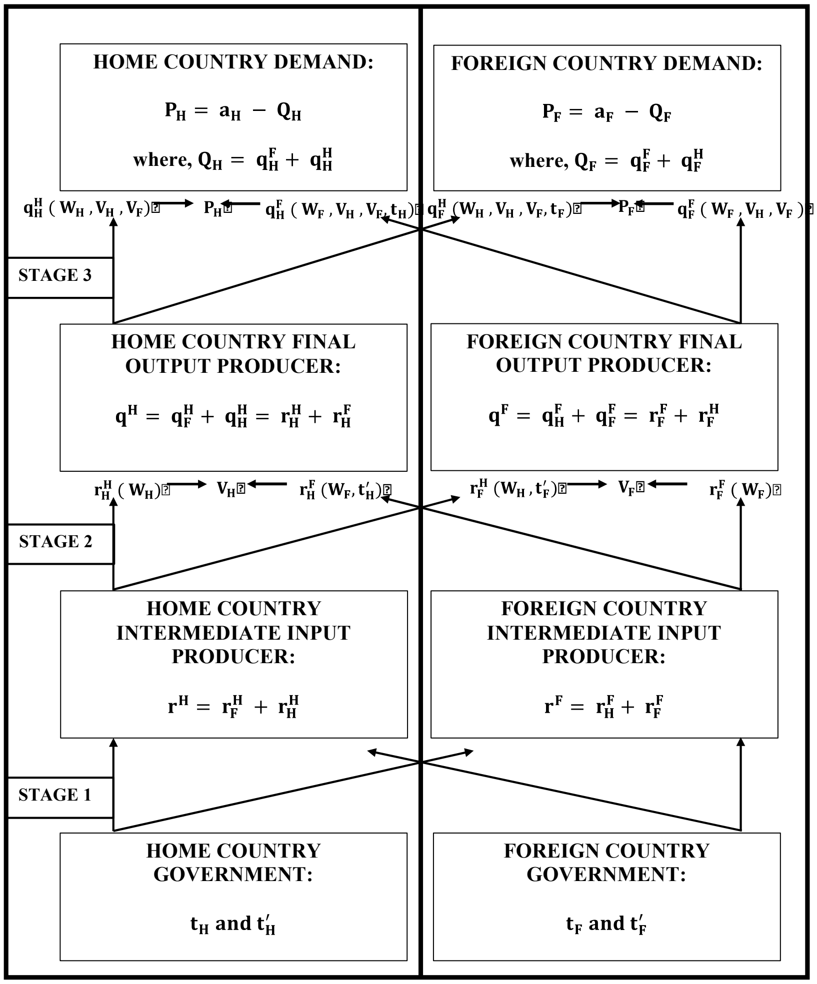
Stage 1: Government of country i (for all i ϵ A) decides to impose specific tariffs of rate t_i and t_i' on the import of final output and of intermediate input, respectively.

Stage 2: Given tariff rates (as determined from stage 1) and the exogenous wage rate (W_i) of each country i (i ϵ A), input producers of different countries decide on how much input to supply in country i by committing in quantity i.e. they decide on the levels of r_i^i and r_i^j ($j \neq i$, i,j ϵ A), respectively and hence, the per unit price of input (V_i) is determined in the market. Thus, V_i is endogenous in our model.

Stage 3: Depending upon the per unit price of inputs (V_i) as determined in stage 2, tariff rates that are determined in stage 1, and the exogenous wage rate (W_i) of each country i (i ϵ A), output producers of different countries decide on how much output to supply to fulfil demand (Q_i) of country i (i ϵ A) by committing in quantities i.e. they decide on the values of q_i^i and q_i^j ($j \neq i$, i,jϵ A), respectively and hence, the price to be charged per unit of final output in country i (i.e. P_i).

Thus, in stage 2 and 3, producers of different countries will play a Cournot Game to decide on their supply of intermediate inputs and final outputs, respectively. These interactions are explained through a schematic representation in Figure 1. Therefore, in the first stage, the governments in the two countries decide on the optimal level of tariffs to be imposed on the imports of final output and intermediate input. After the tariffs are set, intermediate input producers of both the countries decide on the level of intermediate inputs to be supplied to each country's final output market by committing in quantity. In the process, the markets also determine the equilibrium price of input in each country. Thereafter, both countries' final output producers will decide on the level of final output to be supplied to each country, thus determining the price of output. The entire sequential game shall be solved backwardly, as is described in the following section.

Figure 1: Schematic representation of three stages of decisions.



Source: Drawn by Author

4. SOLVING THE MODEL[6]

This section discusses in detail the methodology that we have adopted to solve the model. Using the criterion of backward induction to solve for Subgame Perfect Nash Equilibrium (SPNE), we first solve for the equilibrium quantity and prices in final goods' market, followed by the equilibrium solution in input markets and finally, we solve for the rate of optimal tariffs that determine maximum

[6] Due to analytical difficulties, some of the results have been derived by using Wolfram Mathematica.

social welfare in each of the two countries.

4.1. The Final Goods Markets

The producers in the final output market are assumed to maximize their profits which in turn depend upon the demand for their product and on their cost of production. Each firm perceives each market (in each country) as a 'segmented market'. As a consequence, for each of them, firms make distinct quantity decisions. In each country i, the inverse demand for final output takes the following form (from equation (1)):

$$P_i = a_i - Q_i \qquad \text{for all } i \epsilon A$$

where, P_i is the per unit price of the final output in country i, a_i is the demand intercept for country i and, Q_i is the aggregate quantity demanded by consumers in country i.

The final demand Q_i can be supplied by both the domestic output producer i.e. the one that produces in country i, and the other country's producer.

Thus,

$$Q_i = q_i^i + q_i^j \qquad \text{for all } i, j \epsilon A, i \neq j \tag{2}$$

Given this demand and assuming that the per unit cost of the intermediate input of country i be V_i plus W_i, and given the technological assumption (i.e. one unit of intermediate input and one unit of labour is required to produce one unit of final output), the profit function of the final output producer when it supplies to its own country, can be written as:

$$\Pi_i^{iO} = P_i\, q_i^i - W_i\, q_i^i - V_i\, q_i^i \qquad \text{for all } i \epsilon A \tag{3}$$

where, O represents the final output sector.

Similarly, the profit of the other country's (j) final output producer by supplying to country i's consumers when it imposes specific tariff of t_i on import can be written as:

$$\Pi_i^{jO} = P_i\, q_i^j - W_j\, q_i^j - V_j\, q_i^j - t_i\, q_i^j \qquad \text{for all } i \epsilon A \tag{4}$$

where, t_i represents the specific tariff that country i imposes on the exporter of final output. Now, each country's final output producer will maximize its profit function, from which we get the reaction functions for each of the two final output producers who are supplying to country i. Algebraically, we get,

$$q_i^i = \frac{a_i - W_i - V_i - q_i^j}{2} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (5)$$

$$q_i^j = \frac{a_i - W_j - V_j - t_i - q_i^i}{2} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (6)$$

Since the producers simultaneously decide on the quantities that they will supply to country i, equations (5) and (6) are solved together to obtain,

$$q_i^i = \frac{a_i - 2W_i - 2V_i + W_j + V_j + t_i}{3} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (7)$$

$$q_i^j = \frac{a_i - 2W_j - 2V_j + W_i + V_i - 2t_i}{3} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (8)$$

We assume that both the quantities are positive. As is standard, from equations (7) and (8), it is evident that the quantity supplied by the producer in country i is negatively related to its own per unit cost (W_i and V_i). This is because, higher the marginal cost (which is equal to average cost in our case), lesser will be the profit margin and hence, the producer would produce lesser quantity. While on the other hand, this quantity depends positively on the others country's (i,j ϵ A, i≠j) per unit cost (W_j and V_j). This higher marginal cost of the other country makes it optimal for the country i's final output producer to produce and hence supply more as the final outputs produced in the two countries are strategic substitutes.

Therefore, the total quantity supplied to country i can be represented as:

$$Q_i = q_i^i + q_i^j = \frac{2a_i - W_i - W_j - V_i - V_j - t_i}{3} \qquad \text{for all i, j } \epsilon \text{A, i} \neq \text{j} \qquad (9)$$

As it can be observed from equation (9), the final quantity Q_i is a negative function of each country's input prices. Substituting this value in equation (1) yields the per unit price of the final output in country i, as stated in equation (10) below.

$$P_i = \frac{a_i + W_i + W_j + V_i + V_j + t_i}{3} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (10)$$

As is standard, the price in country i depends positively on the per unit input prices and per unit wages in country i and j, respectively and also on the tariffs that i's government imposes on imports of the final output from country j. Thus, it is easy to observe that in a two-country setup with two firms in each country producing a final and an intermediate good respectively, and following Cournot market interactions, the total quantity of final good supplied in each country in equilibrium depends negatively on both the countries' input prices and on the home country's tariff on imports of final good. Similarly, equilibrium price of the final good in the home country is a positive function of input prices and the tariff imposed on its imports.

This completes the stage 3 to our sequential game. However, a necessary condition that implicitly plays a crucial role in reaching the solution set (equations (9) and (10)) is what is referred to as the "No Arbitrage Condition". Intuitively, it means that the prices in the two markets should be such that no individual (be it any economic agent) can take advantage of the price differential between the domestic and foreign markets and can make profit by buying in one country and selling it in another. Thus, a unique equilibrium exists in each of the two final outputs' market. Assuming that both home and foreign markets have positive demand for final good, the No Arbitrage condition ensures that:

$$P_i \leq P_j + t_i \qquad \text{for all i, j} \in \text{A, i} \neq \text{j} \tag{11}$$

This means that the price of final output in country i should be less than or equal to the price of final output in country j plus the tariffs imposed by country i for no arbitrager to interfere with the functioning of the two markets. So, if any arbitrager in country i tries to buy the homogeneous output in country j, the prices should be such that the cost that it pays for the good (= $P_j + t_i$) should be less than or equal to its own country price P_i. In terms of H and F, this condition (11) can be restated as:

$$P_F - t_F \leq P_H \leq P_F + t_H \tag{12}$$

This possibility of arbitrage is particularly likely to occur in the presence of highly asymmetric demand functions (represented by differing a_i) or wage rates (represented by differing W_i) in the two markets due to which the divergence between the two final prices is so high that it doesn't lie within the bounds or the defined tariff range. Therefore, it is necessary to include the no-arbitrage' constraint in our set up. We shall show below how this constrains the parameter space in equilibrium.

4.2. The Intermediate Input Market

Given the choice of final outputs in Stage 3 of the game, in this stage, the input producers in each of the countries decide on the quantities to be produced and supplied. Based on our technological assumption that one unit of input is used to produce one unit of final output, the quantities of final output derived in stage 3 are used by the input producers to determine their supplies in different countries.

As we already know, the total quantity of final output (q^i) produced by the producer in country i (for all iϵA) is equal to the summation of the quantities that it supplies to both the countries $(q_i^i + q_j^i)$. Algebraically, this is equal to the sum of q_i^i and q_j^i, and hence,

$$q^i = q_i^i + q_j^i = \frac{a_i + a_j - 4V_i - 4W_i + 2V_j + 2W_j + t_i - 2t_j}{3} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (13)$$

This is the derived demand for input by the output producing firm in country i. Thus, the inverse demand function for the input in country i is:

$$V_i = \frac{a_i + a_j - 4W_i + 2V_j + 2W_j + t_i - 2t_j - 3q^i}{4} \qquad \text{for all i, j } \epsilon \text{ A, i} \neq \text{j} \qquad (14)$$

Here, V_i represents the price an input producer gets by supplying intermediate input to final output producer in country i (i.e. the price of input in country i). It is important to note here that even though we are considering the input markets as segmented, yet V_i appears as a function of V_j in equation (14). This interdependence between input prices is a natural outcome as the supplies of the country i's final output producer to both i and j's consumers are added to compute its total demand for intermediate input. Also, due to the segmented nature of the input market as well, the country i's input producer considers V_j as an exogenous variable in our analysis.[7]

Now, based on the total input demand in country i, input producers will compete in quantities and the final good producer in country i will buy its input from the two suppliers, one from its own country and the other from country j. Algebraically,

[7] Similarly, when we solve for the derived demand for input in country j, we find V_j as a function of V_i. However, the same explanation applies here as well, and we assume that the input producer j considers Vi as an exogenous variable throughout the analysis.

$$q^{i} = r_{i}^{i} + r_{i}^{j} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \qquad (15)$$

Here again, intermediate input producers of different countries supplying to final output producer of country i, commit in quantity and play a Cournot game to reach their equilibrium levels of output and price. Thus, the profit function for input supplier in country i when it sells in its own country only, can be expressed as:

$$\Pi_{i}^{iI} = V_{i}\, r_{i}^{i} - W_{i}\, r_{i}^{i} \qquad \text{for all i} \epsilon \text{A} \qquad (16)$$

where, I represents the intermediate input sector.

Similarly, the profit of input supplier j by supplying to the final output producer in country i (for all i, j ϵ A, i≠j) is:

$$\Pi_{i}^{jI} = V_{i}\, r_{i}^{j} - W_{j}\, r_{i}^{j} - t_{i}'\, r_{i}^{j} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \qquad (17)$$

where, t_i' represents the specific tariff that country i's government imposes on imports of intermediate inputs from the foreign market.

Having assumed segmented markets and homogeneous product across countries and with no loss of generality, for each country i producing final output, there will be suppliers of input from different countries, who in turn will maximize their profit function. Solving for the marginal conditions yields the reaction curves for the producers supplying intermediate input to country i's final output producer. Algebraically, these functions are:

$$r_{i}^{i} = \frac{a_{i} + a_{j} - 8\,W_{i} + 2V_{j} + 2W_{j} + t_{i} - 2t_{j} - 3r_{j}^{i}}{6} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (18)$$

$$r_{i}^{j} = \frac{a_{i} + a_{j} - 4W_{i} + 2V_{j} - 2W_{j} + t_{i} - 2t_{j} - 3r_{i}^{i} - 4t_{i}'}{6} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (19)$$

Simultaneously solving equations (18) and (19) yield the quantity that different country input suppliers supply to the final output producer in country i, and these quantities are:

$$r_{i}^{i} = \frac{a_{i} + a_{j} - 12W_{i} + 2V_{j} + 6W_{j} + t_{i} - 2t_{j} + 4t_{i}'}{9} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (20)$$

$$r_{i}^{j} = \frac{a_{i} + a_{j} + 2V_{j} - 6W_{j} + t_{i} - 2t_{j} - 8t_{i}'}{9} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (21)$$

We assume that both the quantities are positive. Equations (20) and (21) show the equilibrium levels of quantities that the intermediate input producer of each country produces and supplies to the i^{th} country final output producer. Both the quantities depend positively on the final demand intercepts of country i and j. Intuitively, this happens because a higher intercept means higher demand for final output, the higher production of which requires more of an input, and hence, the derived demand r_i increases. Similarly, an increase in the input price to be paid by the j^{th} country's final output producer means a rise in its cost of production. As a consequence, the rational producer in country j starts demanding less of that input and so their production of final output falls. This, in turn, extends an opportunity to the final output producer in country i to produce and supply more, given that it continues to face the same V_i as before.

Further, a higher W_i affects the equilibrium quantities via two channels; i). In stage 3, higher W_i raises the cost of production for final output producer in country i, and hence, a reduction in its demand for labour. Given the technological assumption, this leads to a decline in country i's demand for intermediate inputs. This channel simply implies that higher wage cost will lead to lower demand for intermediate input. ii). However, as regards the stage 2, the intermediate input producer in the i^{th} country also faces a high cost of labour which, in turn, leads to a decline in its output and hence in its supply. Therefore, the amount of input that country i producer will supply to its own country will definitely fall (as both channels imply a fall in production) as shown in equation (20). In addition, channel (ii) will affect the relative competitiveness for the intermediate input producer in the other country, whose supply gets positively affected by an increase in W_i. Effectively, a rise in domestic wages means that the foreign input producer gets a bigger share of a smaller input demand from the domestic final goods producer. It is a coincidence that these two channels exactly cancel each other, so the parameter W_i doesn't enter equation (21). W_j enters with a positive sign in equation (20) and a negative sign in (21). This is simply because higher foreign wages reduce the competitiveness of the foreign input producer in both markets.

Additionally, the equilibrium quantities are affected by the three different tariff rates that exist in the two countries. Higher t_i raises the cost for the final output producer in country j for supplying country i and hence produces the same effect as V_j. On the contrary, higher t_j reflects the rise in cost for country i's final output producer and as a result, it enters with a negative sign in the two equations. Finally, higher tariffs on imports of intermediate input imposed by country i (t_i') raises the cost of exporting for the input producer in the j^{th} country. Consequently, its output falls and so does its supply to country i. This increases the market for the domestic producer and hence its supply and demand increase as represented by equation (20).

Hence, the total quantity of intermediate input supplied to country i (which is equal to the quantity demanded by country i) is given by:

$$q^i = r_i^i + r_i^j = \frac{2a_i + 2a_j + 4V_j - 12W_i + 2t_i - 4t_j - 4t_i'}{9} \quad \text{for all i, j} \in A, i \neq j \qquad (22)$$

Substituting the value of q^i from equation (22) in equation (14), yields the price that the intermediate input producers get by supplying to country i, which is,

$$V_i = \frac{a_i + a_j + 2V_j + 6W_j + t_i - 2t_j + 4t_i'}{12} \qquad \text{for all i, j} \in A, i \neq j \qquad (23)$$

Equation (23) shows the equilibrium price of input paid by the i^{th} country final output producer. It depends positively on the demand intercepts of the home and the foreign country. More demand for final output raises the derived demand for intermediate input, which, in turn, increases its price. Similarly, it depends positively on the price of input paid by the j^{th} country's final output producer. This is because higher V_j discourages the production of final output by country j while encouraging it for the other country, i. As a result, the latter's demand for intermediate input increases, thus causing a rise in its price. In addition, higher t_i and t_i' also raise the demand and the price of intermediate input in country i. On the contrary, a rise in t_i raises the cost of export for the final output producer in country i, thereby reducing its production and hence its derived demand for the intermediate input. This, in turn, causes a decline in the price received by the intermediate input producer in country i. Apart from the demand side factors, W_j also plays an important role in determining V_i. Production in the intermediate sector requires labour, the increase in cost of which raises the cost of production of their output and hence, a rise in their price.

Following a similar procedure, we can derive the price that the intermediate input producers get by supplying to country j, i.e.,

$$V_j = \frac{a_i + a_j + 2V_i + 6W_i + t_j - 2t_i + 4t_j'}{12} \qquad (24)$$

Once again, it is important to note that we are considering V_j as an exogenous variable throughout while solving for V_i, and V_i as an exogenous variable while solving for V_j. This essentially happens because the outputs of the two final goods producers depend on the input prices they face in their respective domestic markets. Based on their outputs as functions of V_i and V_j, the demand function for intermediate inputs in each market is obtained by inverting those output functions. Since the input suppliers supply inputs in the two markets (i and j) in a segmented manner, and prices in each market are determined based on other parameters of the model. These prices, however, are also functions of the input price of the other market as it enters through outputs of final goods producers (as evident from equation ((13)). In this manner, we find a set of interdependent prices of inputs as equilibrium outcomes as represented by equations (23) and (24). Now, to find the equilibrium, we need the values of V_i and V_j so that they are mutually consistent. Hence, the two equations are simultaneously solved and the equilibrium in input markets are obtained.

It is imperative to note here that V_i and V_j are determined in the Cournot markets and no one is choosing them as strategic variables. In fact, their interdependence is also not strategic as typically assumed in the context of Bertrand competition where producers play in prices. The two equations are solved simultaneously to find the equilibrium, which is a state of balance with respect to the two input markets. In other words, the firms are treating the markets in a segmented manner but the outcome in input markets are interdependent. Thus, we solve these two price relations simultaneously to obtain consistent equilibrium values of the input prices in the two markets, as represented by the following set of equations (25) and (26):

$$V_i = \frac{7a_i + 7a_j + 36W_j + 6W_i + 4t_i - 11t_j + 24t'_i + 4t'_j}{70} \qquad \text{for all i, j} \in A, i \neq j \quad (25)$$

$$V_j = \frac{7a_i + 7a_j + 36W_i + 6W_j + 4t_j - 11t_i + 24t'_j + 4t'_i}{70} \qquad \text{for all i, j} \in A, i \neq j \quad (26)$$

Once again, equations (25) and (26) represents the equilibrium value of V_i and V_j. Substituting the value of the latter in equations (20) and (21), we get to the reduced-form value of the quantities that different countries' input suppliers supply to the final output producer in the i^{th} country as represented by the following set of equations:

$$r_i^i = \frac{2(7a_i + 7a_j - 64W_i + 36W_j + 4t_i - 11t_j + 24t'_i + 4t'_j}{105}$$

$$r_i^j = \frac{2(7a_i + 7a_j + 6W_i - 34W_j + 4t_i - 11t_j - 46t_i' + 4t_j'}{105}$$

Thus, the equilibrium input-quantities in country i depend on the two countries' market size, wages, and the four tariffs imposed by their respective government. The following proposition summarises the above comparative static results:

Proposition 1. *The total quantity of intermediate input supplied in each country i, in equilibrium, depends positively on the tariff imposed on imports of final goods in the i^{th} country, demand intercept in each of the two countries, wages paid by the j^{th} country, the tariff on import of intermediate input by the j^{th} country. It depends negatively on the wages paid by the i^{th} country, tariff imposed on imports of final output by j^{th} country and tariff on import of intermediate input by i^{th} country.*

The corresponding results hold for intermediate input prices. This completes the Stage 2 to our sequential game. Here also, what is being implicitly assumed is the so-called "No-Arbitrage Condition". The input producers charge within such a range where there exists no possibility for arbitrage i.e. prices of inputs should be such that:

$$V_i \leq V_j + t_i' \qquad \text{for all i, j}\epsilon\text{A, i}\neq\text{j} \quad (27)$$

Intuitively, this means that no arbitrager will find it optimal to buy the input at $V_j + t_i'$ from the j^{th} country producer and resell it at a lesser price of V_i in the i^{th} country. Solving this condition for two countries H and F, we get:

$$V_F - t_F' \leq V_H \leq V_F + t_H' \qquad (28)$$

This ensures the existence of an interior optimum solution in stage 2, even though the inputs produced in different countries are substitutes for each other. Like in stage 3, ensuring a 'no arbitrage condition' in the present stage, implicitly makes sure that no economic agent is able to buy the good in one market and resell in another in order to make profits.

4.3. Welfare Maximization

Once the price and output of final and intermediate input producers are decided, the government in different countries maximize their social welfare to define the optimal tariffs on imports of intermediate input and of final output. As is given by the standard definition, welfare equals the sum of consumer surplus, producer surplus and, tariff revenue.[8] With linear demand curve, consumer surplus is defined as:

$$\text{Consumer Surplus} = \frac{Q_i(a_i - P_i)}{2}$$

Substituting the value of Q_i from equation (9) and the value of P_i from equation (10), we get the simplified value of consumer surplus as:

$$\text{Consumer Surplus} = \frac{(2a_j - 18a_i + 16W_j + 16W_i - t_j + 9t_i + 4t_j' + 4t_i')^2}{1800} \tag{29}$$

Secondly, producer surplus is the profit that a producer gets by selling its products in different markets. Here, in country i, the producer surplus equals the sum of the profit of final output producer (Π_i^O) and that of the intermediate input producer (Π_i^I). The final output producer in country i (Π_i^O) earns profit by selling the final output in its own country i (Π_i^{iO}) and in country j (Π_j^{iO}). Similarly, intermediate input producer earns profit by selling the input to its own country's output producer (Π_i^{iI}) and to the other country's output producer j (Π_j^{iI}). Therefore, producer surplus can be expressed as:

$$PS = \Pi_i^{iO} + \Pi_j^{iO} + \Pi_i^{iI} + \Pi_j^{iI} \qquad \text{for all } i \epsilon A$$

where,[9]

$$\Pi_i^{iO} = P_i q_i^i - W_i q_i^i - V_i q_i^i = \frac{(63a_i - 7a_j + 4W_j - 116W_i + 26t_j + 51t_i + 16t_j' - 44t_i')^2}{44100} \quad \text{for all } i, j\epsilon A,\ i \neq j \tag{30}$$

$$\Pi_j^{iO} = P_j q_j^i - W_i q_j^i - V_i q_j^i - t_j q_j^i = \frac{(7a_i - 63a_j - 4W_j + 116W_i + 114t_j + 19t_i - 16t_j' + 44t_i')^2}{44100} \quad \text{for all } i, j\epsilon A, i \neq j \tag{31}$$

$$\Pi_i^{iI} = V_i r_i^i - cr_i^i - W_i r_i^i = \frac{(7a_i + 7a_j + 36W_j - 64W_i \pm 11t_j + 4t_i + 4t_j' + 24t_i')^2}{3675} \quad \text{for all } i, j\epsilon A,\ i \neq j \tag{32}$$

$$\Pi_j^{iI} = V_j r_j^i - W_i r_j^i - t_j' r_j^i = \frac{(7a_i + 7a_j + 6W_j - 34W_i + 4t_j - 11t_i - 46t_j' + 4t_i')^2}{3675} \quad \text{for all } i, j \in A,\ i \neq j \tag{33}$$

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[8] It is important to note that wages paid to workers in each country i have not been considered while computing welfare. This is because, within the context of our present model, labour is coming from a competitive market and if one extra unit of labour is required, then by paying the competitive wage, a firm can employ that extra unit of labour. Therefore, from social point of view, there will be no change in welfare through wage bill.

[9] Substituting the values from equations (2.10), (2.7), (2.20) and (2.25), we can obtain producer surplus.

The last component of welfare is the government revenue that equals the tariff revenue in our case. Since, the government in each country i imposes specific tariffs of t_i and t_i' on the import of final output and on intermediate input, respectively, this generates revenue for the government in each country i. Therefore, the revenue equals the sum of $t_i\, q_i^j$ and $t_i'\, r_i^j$. From equations (8) and (24), we get,

$$t_i q_i^j = \frac{t_i\,(63a_i - 7a_j - 116W_j + 4W_i - 19\,t_j - 114t_i - 44t_j' + 16t_i')}{210} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (34)$$

$$t_i' r_i^j = \frac{2t_i'\,(7a_i + 7a_j - 34W_j + 6W_i - 11\,t_j + 4t_i + 4t_j' - 46t_i')}{105} \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (35)$$

So, in this stage, the government in country i determines optimal tariffs to be charged from both the intermediate and final output importers, such that the social welfare gets maximized. The welfare in each country is given by the sum of equations ((29) + (30) + (31) + (32) + (33) + (34) + (35)), which is then differentiated with respect to each of the tariff rates to find out latter's optimal values.[10] Further, solving the first order conditions yields:

$$t_i = 0.3377\, a_i - 0.1095\, a_j + 0.0349W_i - 0.4913\, W_j \qquad \text{for all i, j } \epsilon \text{A, } i \neq j \quad (36)$$

$$t_i' = 0.0965\, a_i + 0.0482\, a_j - 0.1359W_i - 0.1535\, W_j \qquad \text{for all i, j } \epsilon \text{ A, } i \neq j \quad (37)$$

From the above equations ((36) and (37)), it follows that both optimal tariffs imposed on import of final output and intermediate input by country i depend positively on its country's demand intercept and negatively on the wages paid by the j[th] country. Apart from these two factors, the demand intercept in the j[th] country and the wages paid in the i[th] country, also act as determinants of the two rates of tariffs. While the tariff on final good imports depends negatively on a_j and positively on W_i, those on imported inputs varies positively with the former and negatively with the latter. The positive relationship between a_i and t_i is true in all strategic trade models. One of the plausible way in which we can interpret other signs, is the following:

As W_i rises, consumer surplus falls because a higher cost of production leads to higher prices in the market, due to which quantity demanded falls. Producer surplus also falls, because of a similar reason – for them, the cost of their input rises. On the other hand, an increase in tariff rate on final goods

10 The second order condition ensures existence of maximum value for welfare.

imports raises two components of producer surplus viz. Π_H^{HO} and Π_H^{HI}. On the whole, the rise in tariffs when cost of labour increases in a country, ensures that the welfare is maximum. This in contrast to Dixit (1988), where optimal tariff is inversely related to domestic marginal costs, or Bhattacharjea (1995) where it is independent of marginal costs. The difference here is that wages enter into the costs of both the intermediate and final goods producers, which also export to the foreign country. However, when looked at the impact on tariff on intermediate inputs, the results show that with a rise in W_i, it is optimal for the government to decrease this tariff rate.

The last component in the equations is the impact of foreign wages, W_j. With a rise in W_j, consumer surplus falls – similar to the effect of a rise in W_i, because consumers consume both domestic and foreign goods. The surplus for the domestic producers rises, because they become relatively more efficient as far as their productions of final and intermediate goods are concerned. Tariff revenue also falls. In this case, it becomes optimal for the government to reduce both the tariff rates on final and intermediate good so as to ensure that welfare is maximized. Table 1 and Proposition 2 summarises the directional effects of the four parameters on the two tariff rates.

Proposition 2. *The optimal tariffs on final output (in any country) depend positively on its own market size and labour cost, and negatively on foreign country's market size and labour cost. However, intermediate input tariffs depend positively on market size (of both the trading partners) and negatively on their wage cost.*

Table 1: Directional effect of change in market sizes and wage rates on final and intermediate goods' tariff rates.

Parameters	**Impact on two tariffs**	
	$\mathbf{t_i}$	$\mathbf{t_i'}$
a_i	Positive	Positive
a_j	Negative	Positive
W_i	Positive	Negative
W_j	Negative	Negative

4.4. Effective Protection under Optimal Tariffs

As noted earlier, effective protection tells about the percentage change in the value added that happens due to movement from a free trade scenario to that with restricted trade.

$$\text{ERP} = \left(\frac{\text{Value Added under Restricted Trade} - \text{Value Added under Free Trade}}{\text{Value Added under Free Trade}}\right) \text{ x } 100$$

Value added of final good sector equals profits earned by home final output producers plus the wages paid to the labour to produce that final output.[11] While writing the welfare function, however, we assumed that the i^{th} country's government disregards wage bill as one of the components because of the assumption that labour comes from a competitive market, and therefore, there will be no change in welfare through a change in wage bill. On the contrary, the final sector's value addition is affected by this bill as W_i is given and labour employment may be dependent on it. There are two sources of profit for the final output producer of country i viz. the profit earned by supplying to its own country (Π_i^{iO}) and by supplying to the j^{th} country (Π_j^{iO}) for all i, j ϵ A, i≠j. Similarly, labour in country i can earn wages by producing for its own country ($W_i q_i^i$) and for country j ($W_i q_j^i$). Therefore, in our case, we can define Effective Rate of Protection as follows:

$$\text{ERP} = \frac{\left(\pi_i^{iO} + \pi_j^{iO} + W_i(q_i^i + q_j^i))\right)_T - \left(\pi_i^{iO} + \pi_j^{iO} + W_i(q_i^i + q_j^i)\right)_{FT}}{\left(\pi_i^{iO} + \pi_j^{iO} + W_i(q_i^i + q_j^i)\right)_{FT}} * 100 \qquad (38)$$

where, FT refers to Free Trade and T refers to Restricted Trade (with optimal tariffs). [12]

Thus, value added by i^{th} country's final output producer under the restricted trade regime can be derived by calculating the value-added components which will include the profit of country i's final output producing firms and the wages paid to labour required to produce that output when both countries are imposing optimum tariffs (as derived from stage 1). While calculating VA at restricted trade, we are assuming that both countries are imposing optimal tariffs.

Now, while calculating value added under free trade, we assume that country i doesn't impose any tariff on its imports of both final good and intermediate input, however, country j can either opt for free trade (i.e. no tariffs on import of both goods) or can impose optimal tariffs as determined by

[11] In our model, we have Value added = Value of output – Intermediate consumption = Profits + wages. Here, we have used profit and wages earned as the definition of Value added, instead of Value of output – Intermediate Consumption, which is the standard definition. This is because we wish to examine the distributional effects of optimal tariffs on profits and wages.

[12] Note here that the wage rate (W_i) paid to labour under free trade and restricted trade are same, as wages are given from outside the model and is not endogenously determined, but the total wages paid under two regimes will be different since the level of employment under them is not same.

maximization of the j^{th} country's welfare. In the case of the former, the value added includes the profit of country i final output producer and the wages paid to labour to produce that final output under free trade (i.e. when t_i, t_j, t_i' and t_j' take the value 0) and we can name that as ERP_1. Here, subscript 1 represents the case when country j doesn't impose tariff on its imports of both final good and intermediate input. In another scenario, when it chooses to impose optimal tariffs on its imports, the profit of country i final output producer under free trade (i.e. when t_i and t_i' take the value 0, and t_j and t_j' take the optimal values from equations (36) and (37), respectively) can be represented as ERP_2. Here, as before, subscript 2 means that the j^{th} country is imposing optimal import tariffs.

Now, with four parameters (a_i, a_j, W_i, W_j) that can take different values on a real number line, it is quite complicated to determine when does tariff on output exceeds tariff on input, or when does ERP (in both cases ERP_1 and ERP_2) become positive, and when it becomes negative. Thus, to better understand the results let us simplify the model as follows.

$$a_j = \alpha\, a_i \qquad\qquad \alpha > 0 \tag{39}$$

where, α represents the relative market size for final goods in the j^{th} country to that of the i^{th} country (for all i, j ϵ A, i≠j).

Further assume that γ represents the ratio of wages paid to labour in country j to that paid in country i. In the other words, we assume that the wages paid in country j are γ proportion of the country i wages. Algebraically,

$$W_j = \gamma\, W_i \qquad\qquad \gamma \geq 0$$

This means that $\gamma = \frac{W_j}{W_i}$ and W_i has to be strictly greater than 0 for γ to be defined. Additionally, we assume that $W_i = \beta\, a_i$, where β relates to the wages paid in country i to its market size. Therefore, for $W_i > 0$, we should always have $\beta > 0$.

Despite making these simplifying assumptions, solving our model leads to complicated expressions. Nevertheless, this modification allows us to compute how ERP changes with any change in the value of γ (i.e., to see in which direction does ERP change as the wage difference reflected by parameter γ, increases). To see this, we will first find out the feasible area (in terms of α, β and γ) that satisfies no arbitrage condition with positive tariffs and positive input and output quantities.[13]

Figure 2a: Feasible plot (a) of α, β and γ.

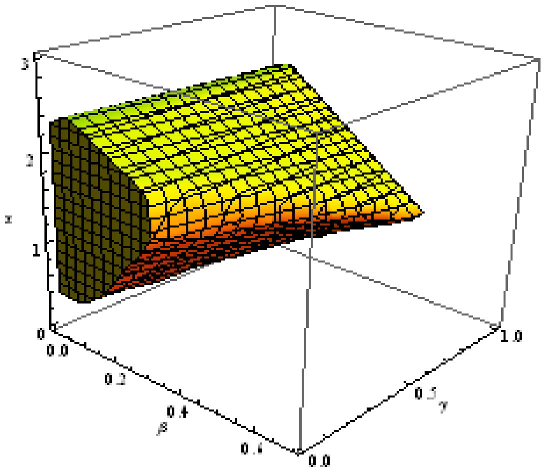
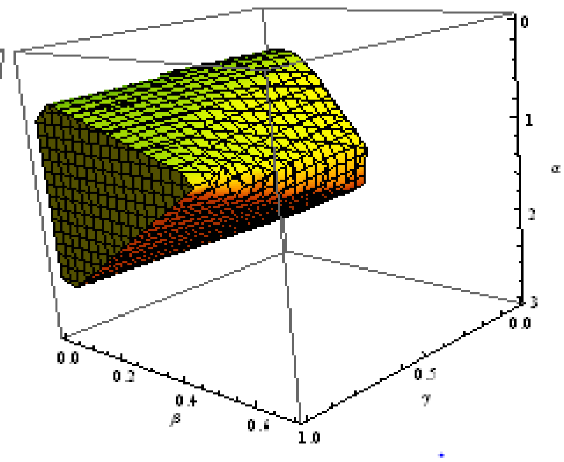


Figure 2b: Feasible plot (b) of α, β and γ.



As represented in figure 2a and 2b (where figure 2b just highlights the back view of figure 2a), the entire yellow shaded area is feasible, i.e., within this area, all the values of α, β and γ are feasible. Next, we derive the partial derivative of ERP with respect to γ.[14] Algebraically, we find that,

$$\frac{\partial \mathrm{ERP}}{\partial \gamma} = \frac{\begin{array}{c}\beta[-0.62 + 0.16\,\alpha^3 + \alpha^2\big(-0.57 + \beta(0.28 + 0.17\,\gamma)\big) + \beta(0.67 + 0.16\,\gamma) - 0.007\beta^3(2.58 + \gamma)(126.44 + \gamma) \\ +\beta^2(3.015 - 0.04\gamma + 0.014\gamma^2) + \alpha(0.29 + \beta(-0.07 - 0.07\gamma) + 0.008\beta^2(-12.92 + \gamma)(5.5 + \gamma))]\end{array}}{(0.09 + 0.09\,\alpha^2 + \alpha\big(-0.04 + \beta\,(-0.02 + 0.01\gamma)\big) + \beta(-0.02 + 0.01\gamma) + 0.0007\,\beta^2(-29 + \gamma)(23.5 + \gamma))^2}$$

with restrictions on parameters as:

$$\alpha \geq 0$$

$$0 < \beta \leq 1$$

$$0 \leq \gamma \leq 1$$

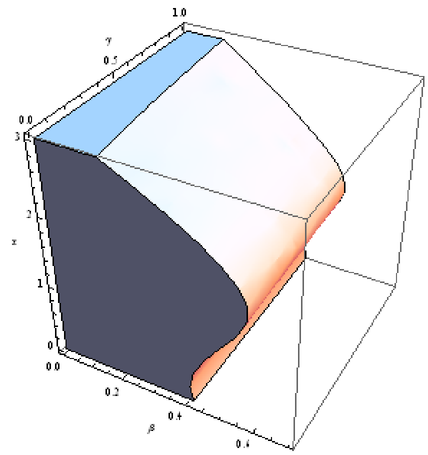
Looking at the derivative, one cannot comment on whether the derivative of ERP with respect to γ is positive or negative. Instead, we examine this issue diagrammatically, by plotting the values of α, β and γ where the derivative is negative.

---

13 In these figures, the range of α and β is determined by the non-negativity conditions for outputs, inputs and tariffs, as well as the feasible region derived above. As for γ, we examine only the range $0 < \gamma < 1$. It is very difficult to analyse the case of $\gamma > 1$, as it complicates the model further. Moreover, we could not look for any other simplification that can be done for $\gamma > 1$ like the way we have done for $\gamma < 1$.

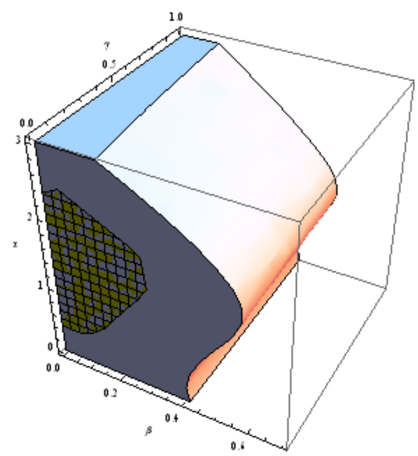
14 This is in regard to ERP_1 measure.

Figure 3: $\frac{\partial \text{ERP}}{\partial \gamma} < 0$



As represented in the figure 3, shaded area shows all the values of α, β and γ, where the derivative of ERP with respect to γ is negative. Next, we will see in figure 4, which superimposes figures 2a and 3, for which feasible values of α, β and γ, is the derivative of ERP with respect to γ negative.

Figure 4: Feasible plot of α, β and γ with $\frac{\partial \text{ERP}}{\partial \gamma} < 0$



In the above figure 4, we find that the entire yellow shaded area (i.e. the feasible area) lies entirely inside the negative derivative expression. Thus, we can say that for all the feasible values of α, β and γ, the derivative of ERP with respect to γ (i.e. $\frac{\partial \text{ERP}}{\partial \gamma} < 0$) is negative. What this implies is that as home wages fall relative to foreign wages (i.e. γ increases), the magnitude of home's effective rate of protection falls (i.e., the magnitude of positive ERP falls or that of negative ERP rises). Therefore, the measure of ERP is sensitive to the wages paid by home i in comparison to country j. Since ERP is defined in terms of value addition in any industry, our finding indicates that *as wages at home fall relative to foreign wages, home country's rate of effective protection also falls.* From equations (36) and (37), a higher value of γ is associated with lower tariff on final output as well as input at home, and the former falls at a higher rate vis-à-vis the latter with any rise in γ. Based on these observations, we establish our next proposition.

Proposition 3. *For all feasible values of our model parameters viz. α, β and γ, the value of positive ERP rises, or that of negative ERP falls (in absolute terms), as the value of γ falls (i.e., as the relative wage disadvantage of the home country increases).*

This means that higher ERP of the downstream sector is justified as a welfare-maximizing policy, the higher the country's relative wage disadvantage. However, it is very complicated to evaluate the relation of positive/negative ERP with IDS in the presence of three parameters. Therefore, we consider two special cases to analyse the optimal values of ERP and IDS at equilibrium tariffs, and see whether IDS is necessary or sufficient for negative ERP, viz:

a) $\gamma = 1$, or a case with wage equality in the two countries, i.e. when we assume $W_i = W_j$.
b) $\gamma = 0$, or a differential wage case where $W_j = 0$ and $W_i > 0$ meaning thereby, that regardless of value of the $\gamma \in [0,1)$, there exists some difference between the two countries' per unit wages.

By computing these two cases, we can further check our above result regarding the link between the incidence of ERP and the value of γ, by examining the possibility of negative ERP at varying levels of the other parameters of the model, i.e, α and β. These two cases are discussed in detail in the next two subsections.

4.4.1. Nominal Wage Equality

In this case, we assume that the nominal wages paid to labour are equalised across the two countries (i.e. $\gamma = 1$) so that

$$W_i = W_j = W$$

This seems reasonable to assume because labour is homogenous in nature and the two countries are not distinguished as far as their endowment of labour is concerned. As a further simplification, we assume that wages in both countries are proportionate to the market size of country i, with the fraction denoted by 'β'. That is, the relation between W and a_i is given by:

$$W = \beta a_i \qquad 0 < \beta < 1 \qquad (40)$$

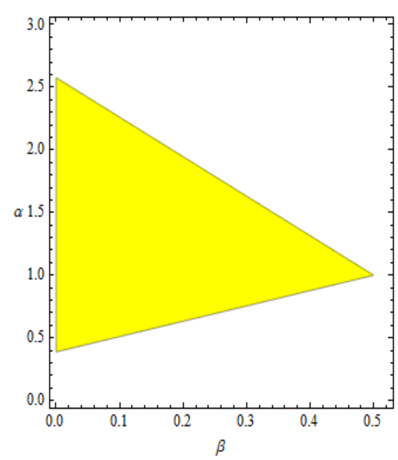
This considerably simplifies our analysis and helps us in producing intuitive results. Now, rewriting the no arbitrage conditions for both final and intermediate goods using the above form (equation (39) and (40)) and assuming positive quantities as well as tariffs, we find,

$$0.388 < \alpha \leq 1 \text{ and } 0 < \beta < -0.317 + 0.817\,\alpha \text{ or}$$

$$1 < \alpha \leq 2.577 \text{ and } 0 < \beta < 0.817 - 0.317\,\alpha \qquad (41)$$

These equations represent the range of feasible values that α and β can take to satisfy the no arbitrage conditions along with the conditions imposed on quantities as well as tariffs as stated above. Hence, within this range, our model is internally consistent. These bounds on the relative market sizes are obvious, because if market sizes are too different, then, the equilibrium prices in the two markets will be very different. This means that beyond some limit, there will exist a possibility for arbitrage to occur. Graphically, Figure 5 portrays the feasible values of α and β. This is same as the front view of Figure 2b, when γ takes a value equal to 1.

Figure 5: Plot of feasible values of α and β under nominal wage equality.



Here, the entire shaded area (yellow) shows those values of α and β for which the feasibility conditions are satisfied, and thus within this range, there exist no possibility for arbitrage or tariffs/quantities to be non-positive, and the model is consistent. For all the values of β, α lies in the range [0.388, 2.577]. As is standard, in our model with two symmetric countries, the lower bound of α equals the reciprocal of its upper bound (i.e. 0.388 = (1/2.577)), which ensures no arbitrage.

Finally to answer our question of interest - "Is IDS an optimal tariff policy?", we define the range of values of α and β such that it becomes optimal for the government to choose such positive tariff rates that lead to occurrence of inverted duty structure in its economy. In our model, we have used specific tariffs (i.e., on quantities of goods imported), therefore, we have to define their ad valorem equivalents (AVE) to compare the tariff on input with that on output.[15] We can find out the respective AVE for optimal specific duty by using the following formula:

$$\text{AVE} = \frac{\text{Specific duty}}{\text{Import price}} \tag{42}$$

For final output in country i, the import price will be P_i and similarly for intermediate input, the import price will be V_i. This implies that the respective ad valorem equivalents can be written as:

$$t_{i\,AVE} = \frac{t_i}{P_i} \quad \text{and} \quad t'_{i\,AVE} = \frac{t'_i}{V_i} \tag{43}$$

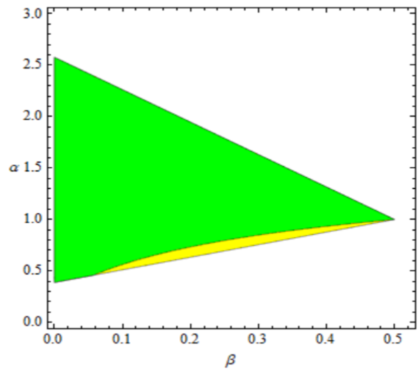
where $t_{i\,AVE}$ is the advalorem equivalent of specific duty imposed on import of final output by country i and $t'_{i\,AVE}$ is the advalorem equivalent of specific duty imposed on import of intermediate input by country i. This allows us to define Inverted Duty Structure in our model. If the AVE tariff on import of intermediate input is greater than AVE tariff on import of final output, then we say that there exists a possibility of IDS in an economy. Algebraically, we can write the condition as:

$$t'_{i\,AVE} > t_{i\,AVE} \tag{44}$$

Therefore, the intersection of equations (41) and (44) give us the range of values of α and β, where the solution is feasible and IDS turns out to be an optimal tariff policy. This is shown by green shaded area in the following Figure 6.

[15] The model becomes quite complicated and almost impossible to solve when we assume ad valorem tariff instead of specific tariffs. The only reason to find AVE is that we can't compare specific duties on inputs and outputs. E.g. if 1 tonne of coal is used to produce 1 tonne of steel, a specific tariff of Rs x per tonne on coal cannot be compared to y per tonne on steel. Because of the complications in solving the model, we have solved the entire model based on specific duty (as has been done in the literature in the past) and then have gone one step ahead to compare the tariff on output and input by finding the ad valorem equivalents of the optimal (specific) tariff rates. However, one should note that if we have started the model with ad valorem tariffs, then in that case, we might have reached a different equilibrium scenario in comparison to the one that we have achieved in our present framework.

Figure 6: Plot of feasible values of α and β for which IDS is an optimal policy under nominal wage equality.



It is clearly evident from the figure 6 that most of the feasible values of α and β support IDS as an optimal policy. There are, however, some other values of α and β for which IDS does not exist and the AVE tariff on final good exceeds the AVE tariff on intermediate input, the range of which is given by the yellow shaded area in figure 6.

As can be observed from the figure 6, for low value of β, there is a higher chance of IDS being an optimal policy. Low value of β also means lower wages being paid in both countries. This means relatively lower price being charged by both the input producer and final output producer. However, the price of output will always be greater than the price of intermediate input (i.e., $P_i > V_i$ to ensure that the final output firm doesn't incur losses). Thus, from (43) and (44), IDS implies $\frac{t_i}{P_i} < \frac{t_i'}{V_i}$. These two forces work together to ensure that the likelihood of IDS increases at lower values of β.

However, it is also reflected from the above figure 6 that there are very low chances of IDS being an optimal policy at lower values of α and higher values of β. This is primarily because in case of high β, it is more likely that output tariff dominates the input tariff rate, which, in turn, also lowers the difference between P_i and V_i. As a consequence, at lower values of α, the likelihood of IDS being an optimal policy further decreases, thereby making $\frac{t_i}{P_i} > \frac{t_i'}{V_i}$.

The above analysis indicates the range of α and β when IDS turns out to be an optimal tariff policy. The next question of interest is – "Does IDS necessarily imply that the effective rate of protection is negative?" To answer this, we first define the range of values that α and β should take such that it becomes optimal for the government to choose such tariffs that lead to negative ERP in either of the two scenarios discussed above (ERP_1 and ERP_2).

Let us first look at what happens when country j doesn't impose any import tariffs, while calculating the value added under free trade by country i. Using equations (41) and taking $ERP_1 < 0$, we thus, find out the range of values which corresponds to such situation and then plot its intersection with the range that defines the feasible values of α and β. The next figure 7 identifies this area, where blue plus red shaded area represents $ERP_1 < 0$ as an optimal tariff policy given the feasibility condition.

Figure 7: Plot of feasible values of α and β for which $ERP_1 < 0$ under Nominal wage equality.

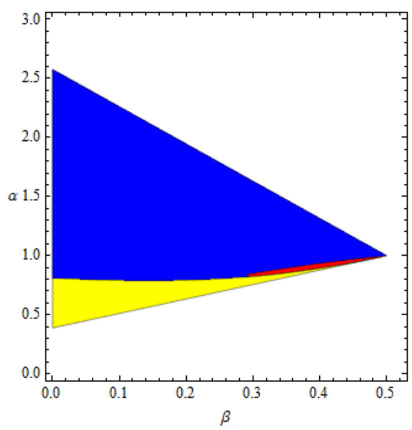
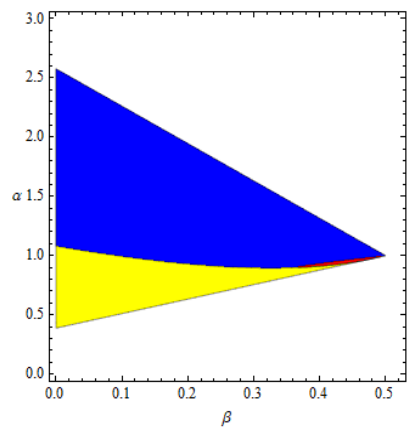


Figure 8: Plot of feasible values of α and β for which $ERP_2 < 0$ under Nominal wage equality.



It is clearly evident from the Figure 7 that for higher values of $\alpha \in [0.8001, 2.577]$ and lower values of β, the possibility of $ERP_1 < 0$ being an optimal policy is higher. It is that case when country j market size is relatively higher than that of country i. This means that the tariff imposed by country i on final output will fall and the tariff imposed by country j will rise (from equations (36) and (37)). Thus, with the fall in tariff imposed by country i, there is an opportunity for j^{th} country final output producer to supply more to country i's consumers. This, in turn, reduces the profit of the i^{th} country final output producer. Moreover, with the rise in tariff on final output by j^{th} country, there will be less opportunity for i^{th} country final output producer to supply in j^{th} country. Thus, both these cases lead to a decrease in quantity produced and hence, profit of the i^{th} country final output producer. As a consequence, at higher values of α and lower β values, i^{th} country firm's value added under restricted trade starts falling behind its value added under free trade thereby leading to negative ERP. Similarly, for some other values of α and β, we have $ERP_1 > 0$, the range of which is plotted in the same Figure 7 and is represented by the yellow shaded area. From these two areas, we find that the ratio of area of positive ERP to negative ERP is given by $(= \frac{0.0339}{0.4764}) = 0.0713.$[16] This ratio will be compared with the corresponding area for the case of wage inequality, to illustrate the general proposition derived above.

Similarly, Figure 8 shows the analysis of effective protection (ERP_2) within the feasible bounds for the other case i.e. when we assume that j[th] country government imposes optimal tariffs while calculating value added under free trade by country i.

Once again, blue plus red shaded plot represents that feasible area where $ERP_2 < 0$ is an optimal policy. Similarly, for all values of α and β in yellow shaded area, we have $ERP_2 > 0$. As was true in case of ERP_1, here also, for higher values of α, the possibility of choosing tariff rates supporting negative ERP as an optimal solution, is greater than when α takes a lower value. From these two areas, we find that the ratio of positive ERP to negative ERP is given by $(= \frac{011208}{041887}) = 0.2675.$

If we compare the shaded regions in Figures 7 and 8, it is clearly evident that the area of negative ERP as an optimal tariff policy decreases as we move from the case of ERP_1 to ERP_2. This is because, for the same values of β, we find that the range of α falls for negative ERP to be an optimal policy as we move from ERP_1 to ERP_2. Therefore, it is worth noting that the level of effective protection rises when the foreign country also imposes restrictions on its imports from the home country, than when it chooses free trade.

Finally, to check if there exists a causal link between inverted duties and negative effective rate of protection, we plot Figure 9 with the first measure of ERP (i.e. ERP_1). In this figure, the blue plus red coloured area represents the range of values when rate of effective protection (ERP_1) is negative while green plus blue coloured area represents the values where IDS exists. For higher values of α, the tariff on final output falls short of that on intermediate input (equations 39 and 40). This, in turn, leads to inverted duty structure in the i[th] country.

[16] The areas have been computed using Wolfram Mathematica.

Figure 9: Plot of feasible values of α and β and for which IDS is an optimal policy and $ERP_1 < 0$ under Nominal wage equality.

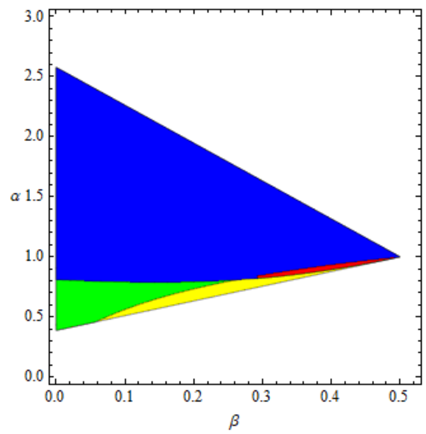
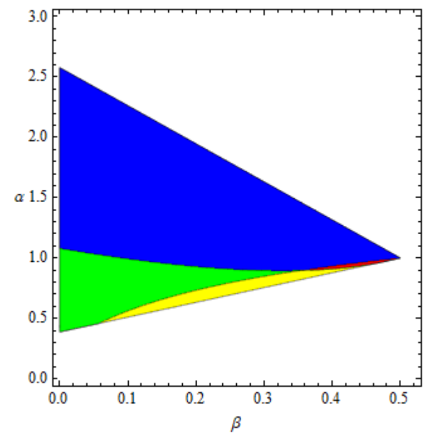


Figure 10: Plot of feasible values of α and β and for which IDS is an optimal policy and $ERP_2 < 0$ under Nominal wage equality.



Similarly, for the second measure of ERP, we plot Figure 10 and use the same colour coding as in Figure 9 to represent the areas for ERP < 0 and IDS. Here also, the blue plus red coloured area represents the range of values when rate of effective protection (ERP_2) is negative while green plus blue coloured area represents the values where IDS exists. It is worth noting that IDS is almost always optimal, especially for the smaller country.

We can conclude from these two Figures (9 and 10) that IDS does not necessarily imply negative ERP. Only the blue shaded area represents the case where both ERP < 0 and IDS coexist. As is evident, such a possibility is more likely at higher values of α, which lead to both IDS and negative effective protection. This case is similar to Corden (1971), where due to the cost-raising effect of high tariffs on inputs that make up a substantial proportion of a sector's costs, ERP becomes negative. However, the red area represents the case where we have negative effective protection, but not IDS.[17] As shown in figures 9 and 10, this is possible for only a very small region of the parameter space, when β takes a very high value within the feasible bounds. That is, only when the wages in the two country are very high. Thus, the value of ERP (positive or negative) is sensitive to even the cost of labour within an economy, and not just to the rates of the two tariffs. So, we cannot say that IDS always implies negative ERP, or vice versa. Therefore, the debate should primarily be concerned about the negative effective protection and not about the existence of inverted duty structure in an economy. As is clearly observed (from Figures 9 and 10),

[17] This case does not specifically correspond to any of the Corden's implications. This could be mainly because Corden assumes perfect competition, while we have assumed imperfectly competitive output and input markets.

whenever the tariffs on intermediate inputs exceed that on the final output, there does not necessarily exist negative effective protection for the final goods sector in country i.

Another important result that is reflected from Figures 9 and 10 is that if we consider both the countries as low wage countries (i.e. if β takes a low value like 0.1), and if country i has a relatively larger market size (i.e. if α is lower than (say) 1.1), then the existence of IDS does not necessarily imply existence of negative ERP. This simply means that if country i has a relatively larger final output market than country j, then the former's final output sector does not need to worry about the inverted duty rates. This is because the existence of IDS does not negatively affect its value addition. However, if country i has a relatively lower market size than country j (i.e., with same β and high α such that α is greater than 1.1) then, in that case, one can state that IDS is leading to negative effective protection in the i^{th} country. Thus, it is in this area, the final output sector's concern about the existence of inverted duty structure needs to be understood by the policymakers.

However, in general, we can state the following proposition:

Proposition 4. *In our model, although IDS is almost always optimal for all equilibria satisfying the no-arbitrage condition, it does not necessarily imply negative ERP under nominal wage equalisation. Negative ERP is associated with IDS only in a country that is smaller or not much larger than its trading partner. For a very small range of parameter values, negative ERP can arise even without IDS.*

4.4.2. Differential Wages

So far, we assumed that the nominal wages equalise across the two countries. However, we know that in reality, different countries might pay different wages to their labour. In our model, this could be due to differing labour productivity coefficients in their agricultural sectors. Taking for instance, the case of a developing and a developed economy, the literature suggests that the former are richly endowed with labour resources and as a result, the factor is available at a lesser wage rate in their economy relative to that of the developed countries, which have access to abundant supplies of capital. Let's for now assume that the foreign country belongs to the former category while the home is a part of the developed world such that $W_j = 0$ while $W_i - W_j > 0$. Thus, we assume that there exists a positive difference between home and foreign country's wage rate and we normalise the latter's wage payment equivalent to zero.

Here, we assume that the wages in the home country can be represented as a fraction 'β' of its market size. Algebraically,

$$W_i = \beta a_i \qquad 0 < \beta < 1 \tag{45}$$

In addition, we continue to assume that equation (39) holds. Now, rewriting the no arbitrage conditions for both final output (equation (12)) and the intermediate input stage (equation (28)) collectively, using the above form (equation (39) and equation (45)) assuming positive quantities as well as tariffs, we get,

$$0.388 < \alpha \le 0.410254 \text{ and } 0 < \beta \le -1.03 + 2.65\,\alpha, \text{ or}$$

$$0.4102 < \alpha \le 0.504 \text{ and } 0 < \beta \le -0.22305 + 0.68\,\alpha, \text{ or}$$

$$0.5044 < \alpha \le 1.48398 \text{ and } 0 < \beta \le 0.034 + 0.178\,\alpha, \text{ or}$$

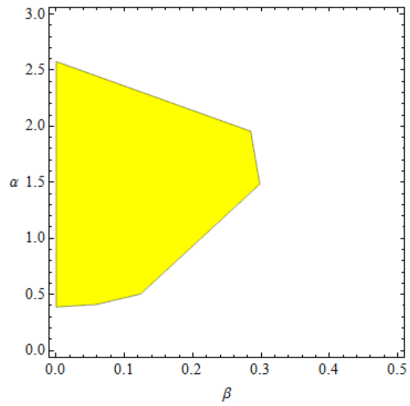
$$1.48 < \alpha \le 1.955 \text{ and } 0 < \beta \le 0.34 - 0.028\,\alpha, \text{ or}$$

$$1.955 < \alpha \le 2.577 \text{ and } 0 < \beta \le 1.18 - 0.458\,\alpha \tag{46}$$

As before, we next plot these inequalities in a 2-dimensional graph to get the feasible values of α and β. The plot is shown in Figure 11 below, which is same as the front view of Figure 2a, i.e., when γ becomes 0.

The shaded area (yellow) represents the values of α and β for which the feasibility conditions are satisfied, and thus within this range, there exist no possibility for arbitrage with positive quantity choices and tariffs. Hence, the model is internally consistent. Furthermore, the lower bound of α equals the reciprocal of the upper bound value (i.e. 0.388 = (1/2.577)), which also verifies the possibility of no arbitrage. This feasible region is smaller than what we got in Figure 5 in nominal wage equality case, the plausible reason for which is explained below.

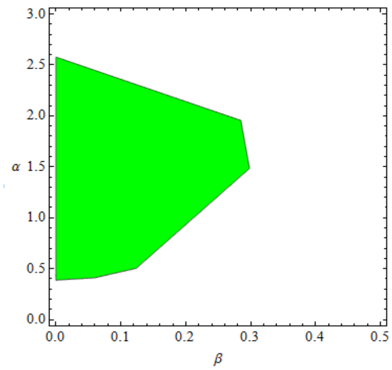
Figure 11: Plot of feasible values of α and β under differential wages.



In all the cases stated thus far, we have restricted our parameter space by assuming the so-called 'no-arbitrage' conditions. This is because in the presence of asymmetric market sizes, prices in the two markets can be very different, thereby raising the possibility of profitable arbitrage opportunities. Similarly, existence of differential wages in home and foreign markets also raises the divergence between the two market prices, which, in turn, strengthens the possibility of profitable arbitrage opportunities. This is the reason as to why imposing the 'no-arbitrage' bounds on the two prices, makes our parameter space even more restrictive in the present case in comparison to the case when we assume nominal wage equality. It is worth noting that in the intra-industry trade as originally envisaged was to explain the possibility of trade between similar countries and the question of arbitrage possibility is naturally ruled out by that (Brander (1981) and Brander and Krugman (1983)). As we are dealing with asymmetric countries with respect to certain parameters of the model the arbitrage opportunity due to divergence in prices is a natural outcome in such setting. To avoid that arbitrage possibility we restrict our parameter within certain bounds and carry out the analysis. In other words, our assumption of segmented market would be valid only when the no-arbitrage condition is satisfied.

We next define the range of the values of α and β such that it becomes optimal for the government to choose such tariffs that lead to an inverted duty structure in the home economy. Taking the difference between AVE tariff on input and output, IDS will exist if $t_{i\,AVE} < t'_{i\,AVE}$ i.e. $\frac{t_i}{P_i} < \frac{t'_i}{V_i}$.

Figure 12: Plot of feasible values of α and β for which IDS is an optimal policy under differential wages.



The intersection between the feasible values and IDS in terms of the two parameters viz. α and β, is given by the green shaded area in Figure 12 and portrays the range where the tariff structure supporting IDS becomes an optimal policy solution for the government. From Figure 12, it is clear that for all values of α and β, the AVE tariff on intermediate input exceeds that on final output, i.e.an inverted duty structure in the home market. Thus, IDS exists in the entire feasible region i.e. there are no feasible values of α and β, which do not imply existence of inverted duty structure.

Thus, this case also verifies the possibility of tariff rates supporting IDS being chosen as optimal solutions by the domestic governments. But IDS should adversely impact industries (relative to free trade) only if it leads to negative ERP. Therefore, we again check if there exists an inter linkage between the two. Following the same procedure as before, we first find out those values of α and β that support negative ERP_1 in Figure 13. We then repeat the steps for the other scenario when the foreign government imposes optimal tariff on its imports and plot the solutions for ERP_2 in Figure 14. In both the Figures, the blue area defines ERP when it takes a negative value, while ERP > 0 is represented by the yellow coloured area.

Finally, to check if there exists a link between inverted duties and negative effective rate of protection, we plot Figure 15 and Figure 16 for ERP_1 and ERP_2, respectively. In both the figures, the blue plus green coloured area represents the case where IDS exists, while the blue area represents the range of values when ERP is negative. For higher values of α, as we can observe from the figures and similar to what we got when we assumed nominal wage equalisation, the tariff on final output falls short of that on intermediate input, i.e.an inverted duty structure in country i. Further, we find that the ratio of positive ERP to that of negative in case when we used the first definition of ERP, i.e. ERP_1 is $(= \frac{0.049}{0.38} =)$ 0.1282, and for ERP_2 is $\left(= \frac{0.1131}{0.3284} =\right)$ 0.344

Figure 13: Plot of feasible values of α and β for which $ERP_1 < 0$ is an optimal policy under differential wages.

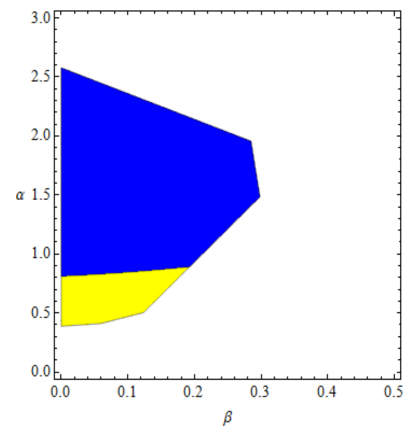


Figure 14: Plot of feasible values of α and β for which $ERP_2 < 0$ is an optimal policy under differential wages.

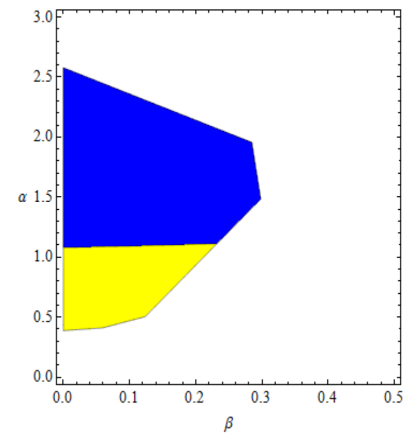


Figure 15: Plot of feasible values of α and β for which IDS is an optimal policy and $ERP_1 < 0$ under differential wages.

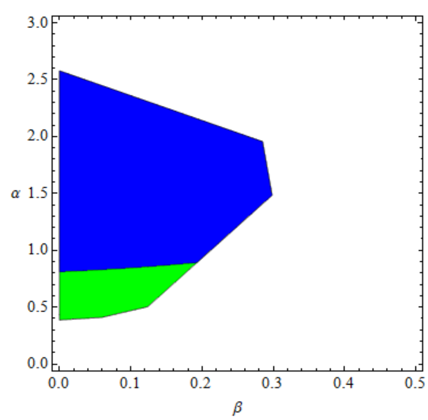
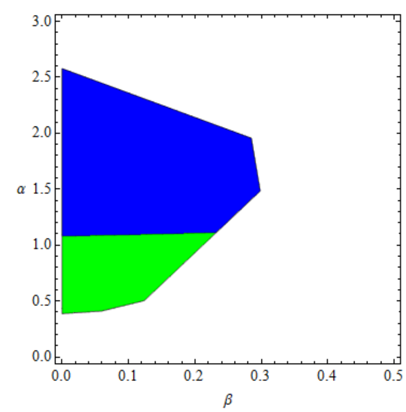


Figure 16: Plot of feasible values of α and β for which IDS is an optimal policy and $ERP_2 < 0$ under differential wages.



Next, we compare these ratios to those observed in case of nominal wage equality. It can be easily observed and verified that as we switch from the differential wages to the nominal wage equality case, the ratio of the area of positive to negative ERP (for both the measures of ERP) falls. This confirms that the incidence of negative ERP rises as γ rises. This is because, as we move from differential wages to wage equality, the wage paid by country j rises and ultimately becomes equal to country i, when γ takes the value 1. As a result, with higher wages, the cost of producing final output rises (and so does the cost of producing inputs and the price of input). And with tariffs also being imposed, the profit of final output producer falls. This reduces the incidence of positive protection and increases that of negative protection.

Once again, our analysis shows that the existence of inverted duty structure does not necessarily imply that ERP is negative. The really strong result is that IDS is optimal for all feasible equilibria that satisfy the no-arbitrage condition, with negative ERP for a subset of parameters represented by the blue area in Figures 15 and 16. However, another point worth noting is that – unlike in the case of nominal wage equality, in the present case, IDS is a necessary condition for negative ERP (though existence of IDS does not necessarily mean that ERP is negative). This argument strengthens our result where we are trying to emphasise that policies supporting inverted duty structures should not necessarily be blamed for poor performance of the incumbent manufacturing industries.

Therefore, our next proposition can be stated as follows:

Proposition 5. *In our model, as in the case with nominal wage equality, IDS does not necessarily imply negative ERP under differential wages. However, unlike the case with nominal wage equality, IDS is both socially optimal and is a necessary condition for negative ERP, for all equilibria satisfying the no-arbitrage conditions.*

The difference in the two regions (in the cases of nominal wage equality and differential wages) arises because of the additional asymmetry in terms of the cost parameters or wages in the present case vis-à-vis the case of nominal wage equality. In fact, this asymmetry restricts the parameter space so much that under differential wages, negative ERP implies existence of inverted duty structure. This is happening because given our setup, optimal output tariffs always fall short of optimal input tariffs. Below we discuss a few important observations from our analyses of the above two scenarios (i.e., differential wages and nominal wage equality case):

Important Remarks

1. There exist optimal tariffs such that they lead to both duty inversion and negative effective protection.
2. In general, the existence of IDS does not necessarily imply a negative effective rate of protection.
3. Considering the case of nominal wage equality, we observe that given the feasible range of α and β, the value of ERP depends on the measure of ERP that we assume (i.e., ERP_1 or ERP_2). However, we find that if both the countries are low wage countries and if country i has a relatively smaller market size vis-à-vis country j (here, relative market size depends on which measure of ERP we

are using,), then existence of IDS necessarily implies that effective rate of protection is negative. To be more precise, any value ofαthat exceeds the threshold (of 0.8 in ERP_1 and 1.1 in ERP_2) sufficiently ensures that IDS is a necessary condition for negative ERP.

4. A similar implication (but with different critical parameter values) also holds in the case of differential wages when we assume that wages in the home country are not much higher, but its market size is relatively smaller than in the foreign country. In that case, duty inversion might lead to negative protection. Further, the critical values for the relative size of the home market vis-à-vis the foreign market (or, α), depend on which measure of ERP we are analysing (given the values of β).
5. Last but not the least, we also find that in the case when we assume different wages in the two countries, inverted duty structure turns out be an optimal policy for all the feasible values of α and β, but once again ERP is less than 0 for only a subset of such values. And IDS is a necessary condition for the existence of negative ERP.

Thus, the two wage scenarios enable us to define the range of values for α and β that makes the domestic government choose such rates of optimal tariffs that do not necessarily lead to negative rates of effective protection.

5. CONCLUSIONS

In the past decade, Indian manufacturing industries have experienced a slowdown not only in their exports, but in overall production as well. The incumbent players, more specifically in the engineering goods industry, metal production, tyre manufacturing, etc., have blamed the existence of inverted duty structure in their respective segments as one of the reasons for their declining international competitiveness. While the government of India has been trying to correct the issue (as is evident from the past few Budget announcements), it is imperative to understand whether there exists a rationale behind the existence of this duty inversion. This is because, if the structure of tariffs supporting duty inversion is optimal for maximizing a country's welfare, and if IDS doesn't necessarily imply that effective rate of protection is negative, then government should not really worry about this and neither should the industries.

The possibility of such cases has also been raised in studies by Corden and others. In fact, our results are associated with the case Corden's study, where negative ERP arises because VA under restricted trade falls short of value added under free trade. This may happen due to the cost-raising effect of high tariffs on items that make up a substantial proportion of a sector's costs. In addition, our findings also correspond to Corden's study since we also observe certain parametric values where ERP does not become negative even in the presence of IDS. However, unlike the conventional framework, we use a 2-country model with two imperfectly competitive industries, viz. an intermediate good and a final good industry and each of the two goods is produced by a single firm within a country. To explain our results intuitively, we specifically emphasise two different cases – one, where we have assumed that the wages paid to labour are equal across the two countries (or what we refer to as 'nominal wage equality') and two, when the countries are assumed to pay different wages to their labour (or the case of 'differential wages'). In addition, in both the cases we have defined two measures of ERP namely ERP_1 and ERP_2. ERP_1 represents a situation when the foreign country doesn't impose tariffs on its imports of both final good and intermediate input while calculating value added by home country final output producer under free trade. On the contrary, ERP_2 assumes that the foreign country imposes optimal tariffs on its imports of both the goods under the same scenario.

Our results from each of the two analyses show that, depending on parameter configurations, there do exist such optimal rates of input and output tariffs that could lead to IDS in an economy, and negative ERP as well. However, our findings suggest that IDS does not necessarily imply negative ERP, thereby implying that the former may not (always) negatively affect the final good industry because the tariff structure is still giving it some protection. So, the government while imposing tariffs should be concerned about the level of protection accorded to a sector and not only about IDS. Nevertheless, it is indeed a matter of concern if effective rate of protection for an industry becomes negative due to existence of inverted duty structure, for in that case, the industry may fare better under free trade than under a restricted trade regime. We also observe such a possibility in our framework. In the nominal wage equality case where the two countries pay similar low wages to their labour, then the likelihood of IDS leading to negative ERP is higher if the home country is relatively smaller in size.

In addition, our model suggests that the consequences of difference in the relative sizes depend upon the measure of ERP that we consider. If the partner economy chooses free trade while calculating value added under free trade, then even a comparatively lesser difference between the two countries' market sizes ensures that IDS is a necessary condition for negative ERP. This situation can arise regardless of whether the tariff-imposing country (whose domestic market is being assessed) is bigger or smaller than the partner country provided the difference between the two market sizes is not very large. This contrasts with the scenario when the partner country opts for restricted trade and imposes (positive) optimal tariffs even when the country under consideration, chooses free trade. In such a case, for duty inversion to coincide with negative ERP, the latter should represent a smaller market in comparison to the foreign country. When analysed in the presence of differential wages, our findings suggest that duty inversion leads to negative ERP if the country (under consideration) is a low-wage economy and also has a smaller market size vis-à-vis the partner. Once again, this relative size depends on which measure of ERP we are analysing. However, unlike the case of nominal wage equalization, in case of differential wages, an inverted duty structure is a necessary condition for negative effective protection.

We also analyse two special cases to check how our results deviate depending upon the specific features of the two trading partners in the world market. In the first case, we assume that there exists demand for the final good only in the home country. Thus, in the absence of any demand for final output in foreign country, both imports and imports tariff on the final good take the value equal to zero. Our analysis shows that this situation is characterized with existence of IDS, and ERP always takes a positive value. The only difference between this and the general case is the range in which ERP varies. This case, therefore, highlights the role of demand in our model. As another possibility, we assumed that there exists demand for final output in the foreign country, but now chooses not to impose any tariffs on its imports of either intermediate input or final output. In this case also, we reach the same conclusion as in our general cases that IDS does not necessarily imply negative ERP.

To conclude, our analyses suggest two broad policy findings: (a) Various Indian industrialists have been making claims that IDS is negatively hampering their growth, but there does exist optimal tariff rates that support IDS. Thus, from the point of view of the entire economy, under certain circumstances, IDS could turn out to be a welfare improving policy outcome. Moreover, existence of IDS does not always necessarily imply negative value addition. Even in the presence of IDS, the output producing firms could be better off than they would have been in free trade situations. Therefore, the debate should be around negative protection and not IDS.

(b) Moreover, while imposing tariffs, government should be aware about the size of its economy with respect to its trading partner. Our two-country framework suggests that if a country is relatively small in market size, then IDS will necessarily lead to negative protection. Thus, in that case, government should try to offset duty inversion, for example by providing drawbacks of duty paid on imported intermediate inputs. In addition, our study also highlights the crucial role played by other domestic variables such as wages in determination of tariff structures and effective rate of protection, which should be considered while trying to correct for the issue of duty inversion/negative protection within an economy.

As far as we are aware, our study is a novel addition to the literature on trade and tariffs, and no earlier researcher has explored interrelations of IDS and effective rate of protection in an oligopolistic market set up.

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