Fabrice Grinda

Tariff Policy with Differentiated Products

Since the Second World War, trade in manufactured goods among industrialized countries has become an increasingly important part of world trade. Today, more than half of world trade is in manufactured goods where trade tends to be monopolistic rather than competitive. In particular, intra-industry trade in such products as cars has emerged, where a two way exchange of goods occurs in which neither country has a comparative cost advantage. Such trade, however, has not given rise to distributive conflicts within each country as one would expect from the traditional perfect competition models of international trade. For instance, the European Community was created without any significant opposition. These traditional models, all of which assume perfect competition, cannot explain such a pattern of trade and the apparent absence of distributive conflict within each country. And yet, until two decades ago, most models of international trade assumed that perfect competition and comparative advantage were the basis for international trade. Policy implications in both cases might differ, creating the need for new models of international trade that incorporate increasing returns to scale and hence, monopolistic behavior.

Specific models of trade in the presence of monopolistic competition have been created, mostly to explain intra-industry trade and to study its potential policy implications. Monopolistic competition arises when scale economies are internal to each firm but small relative to the market. Firms produce differentiated products which are imperfect substitutes for other firms' output in a given industry. Each industry is assumed to have an infinite potential variety of products, but each country is limited in the number of varieties it can produce because of economies of scale. Since consumers value product variety, the potential for beneficial two way trade arises, which increases product diversity in both the home country and the foreign country. With such assumptions, the effect of trade policy differs from that of perfect competition models because in addition to the traditional terms of trade improvements that arise from an optimal tariff policy exploiting monopsony power, tariffs can increase production efficiency, can bring about beneficial changes in variety choice, and can even lower domestic prices.

Under perfect competition, a country which has some monopoly power in world markets, and imports a given good X, faces a rising export supply curve of this good from the rest of the world. If the country used its monopsony power by reducing its imports, it would decrease the price it pays for its imports and improve its terms of trade. Each individual consumer in this country is not large enough to affect the price of the imports. The government can exploit its monopsony power with an import tax. The cost of doing so is the distortion loss because the decrease in consumer surplus is greater than the increase in producer surplus. The figure below illustrates this.

As can be seen from *Figure 1,* in the home market, the consumer surplus decreases by ACDF, while the producer surplus increases by ABEF. Overall, there is a decrease of BCDE illustrated in the international market by area $PTFP_F$. However, the government's tariff revenue is PTT^*P^* such that the net effect is a distortion loss of TFG and a gain of $P_FGT^*P^*$. Since the loss is a triangle and the gain is a rectangle, as t decreases to zero, the loss gets smaller faster than the gain. There is a first order gain, and a second order loss. It can be shown that the optimal tariff is $\tau_{imp} = \frac{1}{\varepsilon^*-1}$, where ε^* is the elasticity of foreign elasticity of import

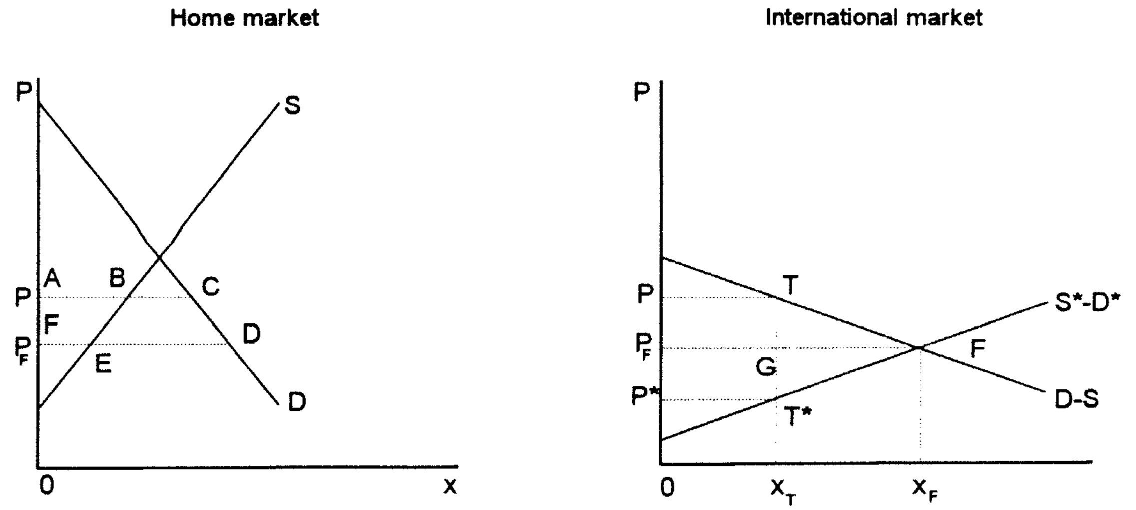

Figure 1.

Home imports: D-S
Foreign exports: S*-D*

demand. If the country has no monopsony power, it faces a perfectly elastic foreign supply curve such that the only effect of the tariff is a distortion loss and the optimal tariff is zero.

In the case of monopolistic competition, in the simplest and most traditional models,[1] a tariff does not affect the elasticity of demand faced by an individual producer, thus the number of goods produced are unchanged, and the net effect of the tariff is the same as it would be if the trade pattern had emerged through comparative advantage. The terms of trade improvement that took place in the perfect competition model applies here; therefore, there is a small optimal tariff. Since the producers are by definition price setters, the home country has some monopsony power; therefore, its optimal tariff is always positive regardless of its size.

A stronger case can actually be made for installing a small tariff in the monopolistic competition case because it can be shown that even if no terms of trade improvement occurred, a small tariff would improve welfare in the country that installed it. In monopolistic competition, suppliers set price equal to marginal revenue and profits are zero (because of free entry) such that prices are equal to average cost and greater than marginal social costs. Tariffs can improve welfare by increasing demand for the home differentiated products closer to what it would be if price was equal to marginal social cost. A small tariff will raise the price of imported differentiated goods such that consumers substitute for the home differentiated good. As seen before, for small tariffs, the difference of tariff revenue minus the distortion loss is small and positive, increasing welfare, and the increase in domestic consumption of differentiated products further increases welfare because the new quantity demanded of differentiated products is closer to the optimal quantity than before. Of course, a tariff is only a second best policy because it causes a distortion to affect the relevant margin. A subsidy would be the first best policy because it directly affects the margin where the problem occurs without any secondary or by-product distortion at some other margin. *Figure 2* below illustrates this.

As can be seen, when no tariff is imposed, domestic consumption is x_1, of which x_i is domestic output and the difference is imported. Domestic output is too small because the marginal social cost is below the equilibrium world trading price. Ideally, domestic consumption should expand to point x_0 where MSC equals P^*. Each marginal unit of output expansion beyond x_i increases welfare by the difference between P^* and marginal social cost. A production subsidy is the best policy because it can equate MSC and P^*, increasing welfare by ABC. When such a policy is used, the equilibrium price remains P^* and imports

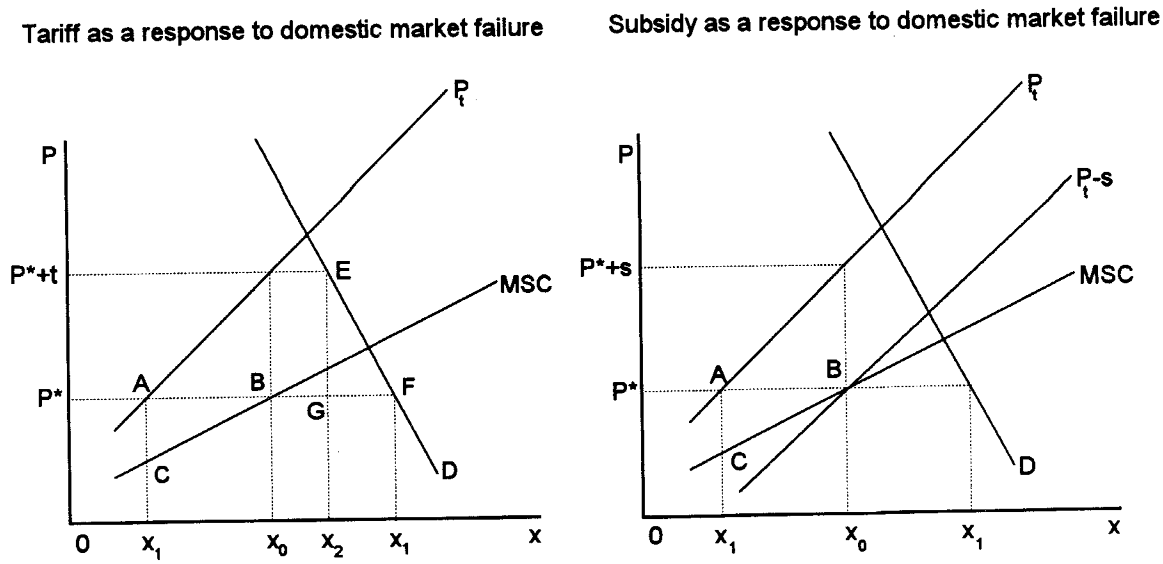

Figure 2.

go down, which suggests that tariffs could also be used. Assuming there are no terms of trade improvements resulting from the tariff, the new equilibrium price becomes $P^* + t$, overall consumption decreases to x_2, but domestic output can increase to x_0. This brings about the increase in welfare ABC, and a decrease EFG. This tariff is not optimal because for the last unit increase in domestic output the welfare gain is smaller than the welfare loss. However, for decreasing values of the tariff it can be shown that the welfare gain decreases slower than the welfare loss, such that there exists an optimal tariff where the marginal benefit from increasing the tariff a little equals the marginal cost.

In special cases, tariffs can also improve welfare by actually lowering price in the country installing them.[2] Venables shows the mechanism by which this occurs in his model which adds high transportation costs to previous models. As a result, consumers in a given country consume mostly the domestic variety of goods. A tariff increases the prices of the foreign varieties and induces substitution towards domestic goods. Since these goods do not incur the high transportation costs, the average cost of the differentiated product falls, increasing home welfare. In some sense, this model is more realistic because home consumption of domestic varieties is higher than that of foreign varieties, as actually occurs in most countries (for instance, Americans consume 75% domestic cars and trucks and 25% foreign). However, the restrictions of the model are such that these gains are unlikely to be possible in many industries. As a result, this model can probably not be used to describe the standard consequences of the installation of a tariff in an intra-industry trade context; however, the potential for further welfare improvements resulting from a tariff again improves the case for installing a small tariff.

In light of the evidence presented above, the case for welfare improving tariffs is much stronger in the case of monopolistic competition than in perfect competition. Of course, when both the home country and the foreign country install tariffs, welfare may decrease in both countries. This, however, does not entirely weaken the policy implications we have seen above. The models can represent trade among countries with similar levels of development or trade between industrialized and developing countries. If the former is the case -- because similar countries tend to have a tit-for-tat trade policy with respect to one another -- there are no policy implications of this model except that countries are better off not installing tariffs at all. If the model represents trade between an industrialized country and a developing country, as a result of the developing country's smaller importance as a trading partner and as a result of the two levels of GATT membership where developing countries are allowed to maintain higher tariff rates than developed countries, the developing country might be able to install a small tariff without retaliation from the industrialized country. This situation mimics that of the above mentioned monopolistic competition models such that there is a small optimal tariff that the developing country can install to improve its welfare. Of course, if developing countries all impose tariffs on each others' products as well as on the products of industrialized countries, then the tariffs would be welfare reducing when they trade among themselves and welfare improving when they trade with developed countries who don't retaliate, and the overall result would be ambiguous.

A more important flaw of the monopolistic competition models described above is that they assume intra-industry trade in all manufactured-goods sectors. However, most countries do not produce all the differentiated products that their trading partners produce. This is easily viewed in the case of trade between developing countries and industrialized countries, but, is also relevant among countries with similar levels of development. One of the explanations of this phenomenon is the existence of some internal and external dynamic scale economies resulting in monopolistic production with average costs that decrease when the cumulated quantity of past output increases, locking in production where it emerged through some historical accident. For instance, in the model, France and the US could be trading, and France could be producing autos, while the US could be producing autos and microprocessors (Intel, AMD, and Cyrix for example are all American). A recent model by Romer[3] describes the welfare consequences of a tariff on imported differentiated products in a country where consumers only consume those differentiated products. Trying to extract monopoly rents from producers of imported differentiated products decreases the number of available varieties, thus reducing welfare in the country imposing the tariff. Simply removing local production of differentiated products from the previous models results in opposite policy consequences. Indeed, a case could be made for subsidizing the imports so their producers price products at their marginal social cost. A simple change in the assumptions of the model greatly changes the consequences, suggesting that one should be reserved in making policy suggestions based on a given model.

Romer's model errs because it assumes that there is only one way trade in differentiated products, and because it assumes only domestic consumers consume these products. Since the Gros, Helpman and Flam, and Venables models err by ignoring one way trade in differentiated products, a reconciliation of the two types of models can be designed in a model including both intra-industry trade and one way trade in differentiated products. This would allow us to see how tariffs affect welfare under different assumptions.

In designing such a model, let us assume that the home country consumes both some differentiated products only made abroad, and some differentiated products made both abroad and locally. Let us also assume that these two types of differentiated products are poor substitutes for each other. A tariff on the differentiated good made only abroad would increase prices for that type of good, inducing substitution towards the other types of differentiated goods. The effect on welfare would depend on the amount of monopsony power of the home country, on the level of substitutability of the two types of differentiated products, and on the extent of the decrease in consumer surplus from consuming more of the other variety of goods. The results would no longer be as clear as in the Romer model; however, our assumption that the products are poor substitutes for each other suggests that people will pay the higher price without decreasing their consumption much, hence experiencing a decrease in utility through having less variety to choose from and from having to pay a higher price.

The welfare effects of a tariff on the differentiated products made both locally and abroad could also become ambiguous because home consumers, in addition to substituting domestic varieties for foreign varieties, might substitute consumption of that type of differentiated product for the type only produced in the foreign country. By not increasing consumption of the domestic variety by as much as in the model where such substitution is ignored, the correction of the domestic market failure would be reduced, and the potential improvement from reducing transport costs would be weakened (if the other differentiated products also incur similar transportation costs). However, since we assumed that the two types of differentiated products were poor substitutes, most of the substitution will come from the foreign variety to the domestic variety of the same type of differentiated products rather than across product types, thus this tariff probably improves welfare.

Let us now study more formally the differences between the "traditional" Gros, Helpman and Flam, and Venables models and our suggested model. To do so, let us first design a much simplified "traditional" model where the installation of a tariff improves welfare, we can then change the home country's utility function to include another differentiated product sector where all production takes place abroad. Our simplified model is not as sophisticated as the previous models because our aim is to study how the basic conclusions of the previous models differ when we change the assumptions. To do so, we only need to study welfare in one country, therefore we can choose to ignore utility changes in the foreign country, greatly simplifying the model. We can also ignore sophisticated assumptions such as including research and development (as in Helpman and Flam). We can further design the model such that the welfare improvements from the tariff result from the home country monopsony power and from the reduction in the domestic market failure rather than from changes in price indices. This allows us to ignore transportation costs and the consumer preferences for domestic goods which are in the Venables model. This simplification is all the more justifiable since we have seen that the assumptions of the Venables model are not relevant for many industries.

In our simplified model, we assume that the home country produces some composite commodity under constant returns to scale, while both countries make a type of differentiated good produced with increasing returns to scale. For simplicity, we also assume that the home country's utility depends only on its consumption of differentiated products, and that the foreign country consumes only the homogeneous product. The home country's representative individual has a utility function:

$$U=\left[\sum_{i=1}^{n_1} x_{1i}^{\frac{\sigma-1}{\sigma}}+\sum_{i=1}^{n_1^*} x_{1i}^{*\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \qquad \sigma>1$$

where x_{1i} is the quantity of the i'th home produced variety of good x_1, x^*_{1i} is the quantity of the i'th foreign produced variety of good x_1,[4] n_1 is the number of product varieties of good x_1 made in the home country, n^*_1 is the number of product varieties of good x_1 made in the foreign country, and a is the elasticity of substitution between any two products. It is assumed that the utility function has the Dixit-Stiglitz (1977)[5] form of constant elasticity of substitution. Given these assumptions, we want to find the general equilibrium solution in order to study how tariffs affect the model.

It is well known that when utility takes the form presented above, the demand functions for differentiated products are:

$$x_{1i}=\frac{p_{1i}^{-\sigma}}{\sum_{j=1}^{n_1} p_{1j}^{1-\sigma}+\sum_{j=1}^{n_1^*} q_{1j}^{*1-\sigma}}E$$

$$x_{1i}^*=\frac{q_{1i}^{*-\sigma}}{\sum_{j=1}^{n_1} p_{1j}^{1-\sigma}+\sum_{j=1}^{n_1^*} q_{1j}^{*1-\sigma}}E$$

where E represents aggregate spending in the home country, p_{1i} is the price of the i'th home produced variety of good x_1, and q^*_{1i} is the home country price of the i'th foreign produced variety of good x_1. $q^*_{1i} = p^*_{1i}(1+t_1)$ where p^*_{1i} is the price foreign producers receive for x^*_{1i}, and t_1 is the *ad valorem* tariff rate the home country places on differentiated products x^*_{1i}.

To find the market clearing price and quantities of differentiated products, we maximize the representative firm's profits, where c is the firm's constant marginal cost in the home country, and f is its fixed cost. Profit for firm i of home country producing good x_{1i} is:

$$\pi_{1i} = x_{1i}(p_{1i} - c) - f$$

To maximize the firm's profit, we set marginal revenue equal to marginal cost:

$$\text{FOC:} \quad p_{1i} = \frac{c}{\frac{\sigma-1}{\sigma}} = \frac{\sigma}{\sigma-1}c$$

We assume that a single firm is small relative to the market such that it does not influence the quantity and price indexes, thus views itself as facing a demand curve of elasticity α.

We also assume that each country is endowed with a fixed quantity of a single factor of production: labor. Since labor is the only factor of production:

$c = a_{x_1}w$ where a_{x1} is the labor requirement to produce one unit of x_1 and w is the real wage.

$f = b_{x_1}w$ where b_{x1} is the fixed labor requirement to produce one unit of x_1.

$$p_{1i} = \frac{\sigma}{\sigma-1}a_{x_1}w$$

A similar procedure can be used for the foreign country yielding the following profit equation for firm i of the foreign country producing x^*_i:

$$\pi^*_{1i} = x^*_{1i}(p^*_{1i} - c^*) - f^*$$

$$\text{FOC:} \quad p^*_{1i} = \frac{c^*}{\frac{\sigma-1}{\sigma}} = \frac{\sigma}{\sigma-1}a^*_{x_1}w^*$$

For simplicity, we make the traditional assumption that each type of differentiated product is supplied by a single firm, and that each firm supplies only one product type. All firms in a particular country are symmetric such that:

$$p_{11} = p_{12} = \ldots = p_{1n_1} = p_1$$

$$p^*_{11} = p^*_{12} = \ldots = p^*_{1n^*_1} = p^*_1$$

We can now substitute these results in the original profit equations:

$$\pi_1 = \frac{p_1^{-\sigma}}{n_1 p_1^{1-\sigma} + n_1^* q_1^{*1-\sigma}} E(p_1 - a_{x_1}w) - b_{x_1}w$$

$$\pi_1 = \frac{p_1^{1-\sigma} - a_{x_1} w p_1^{-\sigma}}{n_1 p_1^{1-\sigma} + n_1^* q_1^{*1-\sigma}} E - b_{x_1}w$$

$$\pi_1 = \frac{\left(\frac{\sigma}{\sigma-1}a_{x_1}w\right)^{1-\sigma} - a_{x_1}w\left(\frac{\sigma}{\sigma-1}a_{x_1}w\right)^{-\sigma}}{n_1\left(\frac{\sigma}{\sigma-1}a_{x_1}w\right)^{1-\sigma} + n_1^*\left[\left(\frac{\sigma}{\sigma-1}\right)\left(a^*_{x_1}w^*(1+t_1)\right)\right]^{1-\sigma}} E - b_{x_1}w$$

Simplification of the above equation yields the following maximized profit equation of a single representative firm in the home country:

$$\pi_1 = \frac{\left(a_{x_1}w\right)^{1-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma} + n_1^*\left(a^*_{x_1}w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{E}{\sigma}\right) - b_{x_1}w$$

We can also compute the representative firm's output of x_1:

$$x_1 = \frac{\left(a_{x_1}w\right)^{-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma} + n_1^*\left(a^*_{x_1}w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E$$

Similarly, substituting the original profit equation for the foreign country yields the maximized profit equation for a single firm in the foreign country:

$$\pi^*_1 = \frac{(1+t_1)^{-\sigma}\left(a^*_{x_1}w^*\right)^{1-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma} + n_1^*\left(a^*_{x_1}w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{E}{\sigma}\right) - b^*_{x_1}w^*$$

We can also compute the representative firm's output of x^*_1:

$$x^*_1 = \frac{\left(a^*_{x_1}w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma} + n_1^*\left(a^*_{x_1}w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E$$

An additional condition on these maximized profit equations arises from the possibility of entry or exit in the industry. Since no barriers to entry or exit are present, profits are competed away and have to be equal to zero.

We now have to find the labor market equilibrium to impose an upward ceiling on production. The home country sells N units of the composite commodity at marginal cost in the foreign country: $p_N = a_N w$ where a_N is the labor requirement to produce one unit of N.

The home country's labor equilibrium is: $n_1 a_{x_1} x_1 + n_1 b_{x_1} + a_n N = L$ which we find by multiplying $n_1 x_1$, the number of units of x_1 made, by a_{x1}, the labor requirements to make one unit of x_1. In order to find the required labor input to produce the equilibrium total output of x_1, we then add the labor requirements for the fixed component of the production of x_1 and the labor requirement for the production of N.

The foreign country labor equilibrium is:

$$n_1^* a_{x_1}^* x_1^* + n_1^* b_{x_1}^* = L^*$$

Finally, since the model only has one time period, trade has to be balanced. The balanced trade condition implies that the value of the imports of the home country has to equal the value of its exports: $p_N N = n_1^* p_1^* x_1^*$

The two maximized profit equations, the labor equilibrium equations, and the balanced trade equation define the general equilibrium. However, the latter three equations in their current form cannot be used to solve for the variables of the model: n_1, n^*_1, N, w, and w^*.
By substituting x_1, x^*_1, p^*_1, and p_N by their corresponding values in these three equations, we can express them in terms of the parameters of the model:

$$\frac{n_1 a_{x_1}\left(a_{x_1}^* w^*\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E + n_1 b_{x_1} + a_n N = L$$

$$\frac{n_1^* a_{x_1}^*\left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E + n_1^* b_{x_1}^* = L^*$$

$$a_N w N = \frac{n_1^*\left(a_{x_1}^* w^*\right)^{1-\sigma}(1+t_1)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}E$$

We can now write the five equations which allow us to obtain the general equilibrium. First we have the two maximized profit equations with the zero profit condition:

$$\pi_1 = \frac{\left(a_{x_1} w\right)^{1-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{E}{\sigma}\right) - b_{x_1} w = 0$$

$$\pi_1^* = \frac{(1+t_1)^{-\sigma}\left(a_{x_1}^* w^*\right)^{1-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{E}{\sigma}\right) - b_{x_1}^* w^* = 0$$

Then we have the home and the foreign labor market equilibria respectively:

$$\frac{n_1 a_{x_1}\left(a_{x_1}^* w^*\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E + n_1 b_{x_1} + a_n N = L$$

$$\frac{n_1^* a_{x_1}^*\left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)E + n_1^* b_{x_1}^* = L^*$$

Finally, we have the equation representing the balanced trade condition:

$$a_N w N = \frac{n_1^*\left(a_{x_1}^* w^*\right)^{1-\sigma}(1+t_1)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}E$$

So far, our model lacks a monetary instrument; therefore, nothing defines the price level. We are free to choose a numeraire and measure prices against the numeraire. Of course, the choice of the numeraire has no effect on relative prices and magnitudes.[6] As our numeraire, we will use E = 1, because it allows us to ignore the effects of tariff revenue on aggregate expenditures which greatly complicates the general equilibrium equations. We can now solve for n_1, n^*_1, N, w, and w^*.

Given that we are ultimately interested in studying the welfare consequences of tariff changes, we will also substitute in the original utility function our computed parameters for x_1 and x^*_1:

$$U=\left[\sum_{i=1}^{n_1} x_{1i}^{\frac{\sigma-1}{\sigma}}+\sum_{i=1}^{n_1^*} x_{1i}^{*\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

$$U=\left[n_1 x_1^{\frac{\sigma-1}{\sigma}}+n_1^* x_1^{*\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

$$U=\left[n_1\left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(E)\left(a_{x_1}w\right)^{-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma}+n_1^*\left(a_{x_1}^*w^*(1+t_1)\right)^{1-\sigma}}\right]^{\frac{\sigma-1}{\sigma}}+n_1^*\left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(E)\left(a_{x_1}^*w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1}w\right)^{1-\sigma}+n_1^*\left(a_{x_1}^*w^*(1+t_1)\right)^{1-\sigma}}\right]^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

Since there are no closed form solutions to the general equilibrium, we must calibrate the model and use numerical methods[7] to find the equilibrium values of the different variables. As we can see from the data above, for all the tested parameters[8] an increase in the tariff rate decreases w, decreases w^*, decreases N, increases n_1, does not affect n_1^*, and increases utility. It seems obvious from the labor supply equation for the foreign market that n_1^* is fixed because the foreign country produces only differentiated products and cannot use its labor for other purposes. Therefore, the number of differentiated products produced is fixed by the labor supply, and the wage rate adjusts to ensure the zero profit condition. The tariff creates a gap between what foreign producers receive for their output and what domestic consumers pay for the foreign differentiated products. Being the only consumer of the foreign differentiated products, the home country faces the entire foreign supply curve of foreign differentiated products and decreases the price it pays for the foreign output by installing the tariff, thus improving its terms of trade. For instance, from the data it can be seen that the price the home country pays for the foreign output goes down by 15.25 percent for a 10 percent tariff. Since the home country's exports decrease in price by 6.78 percent, the net effect is an improvement in the home country's terms of trade (the percent change in price is simply the percent change in wages because the other components of price are assumed to be fixed).

The intuition for the other results is that by increasing the price of foreign differentiated products, the tariff shifts home demand from foreign to domestic differentiated products. This enables domestic producers to sell larger quantities at the initial price, making it profitable to raise prices and expand production. Since the demand shift raises the profitability of home production, it causes the entry of firms in the differentiated products market to restore the zero profit condition. The labor supply is fixed, therefore the entry of firms in the domestic differentiated goods sector implies that these firms exit the homogeneous goods sector. Since the number of firms in the foreign market does not change, and since there are more firms producing differentiated products in the home market, there is an increase in product variety which results in an increase in welfare caused both by the increase in variety and by the increase in domestic production of domestic differentiated products which brings output closer to what it would be if firms faced the marginal social cost of their production. This explanation seems to hold in most cases, because for all the tested values of the parameters of the equations, different values do not change the sign of the effect of the tariff on welfare, but merely change the size of the response. For instance, a greater elasticity of substitution between differentiated products decreases the utility gain from the tariff. For suppliers, α is the elasticity of demand for their products, the greater the elasticity, the lower their monopoly power, hence the lower the gain from producing more differentiated products since the price would then be closer to marginal social cost than if the firms had more monopoly power. The lower the degree of monopoly power, the lower the rents that can be extracted from foreign firms. Also, the greater the number of firms originally producing the differentiated product in the home country (affected by a_{x1} for instance), the lower the gain from the tariff -- because, percentage wise, the larger the original number of firms producing the differentiated goods, the lower the increase in the number of firms as a result of the tariff.

Overall, since for all the tested values of the parameters of the equations there is a welfare improvement as a result of the tariff, we conclude that in most cases, in this model, tariffs are welfare improving. Of course, the numerical values obtained from the model are wrong. There is no reason to believe that utility takes the Cobb-Douglas form or that it is independent of consumption of the homogeneous good. In addition, assuming that differentiated products are consumed only in the home country overestimates the effect of a tariff because it overestimates the monopsony power of the home country. The increase in utility is also exaggerated because the decrease in the production of the composite commodity resulting from the tariff is ignored in the utility function. Lastly, the biggest flaw in our model is that we assumed that foreign consumers only consume the home country's good regardless of the tariff installed by the home country. As a result, the optimal tariff for the home country is an infinitely large tariff driving foreign wages to zero and increasing domestic production of the differentiated products, resulting in an infinitely large domestic level of utility.

Despite these flaws, the model remains useful since it carries the same policy implications as other "traditional" models. We can now modify it to see how adding a new differentiated goods sector, where all production takes place abroad, and all consumption takes place in the home country, affects our previous conclusions. For simplicity, let us assume that the home country's utility depends only on its consumption of differentiated products made both at home and abroad, and on the differentiated product only made in the foreign country. As before, the homogeneous product is only made in the home country and is only bought by foreign consumers. The home country's representative consumer now has a utility function:

$$U = C_1^{\beta} C_2^{1-\beta}$$

where C_1 is the sub-utility function defined over differentiated products x_1 and C_2 is the sub-utility function defined over differentiated products x_2.

$$C_1 = \left[\Sigma_{i=1}^{n_1} x_{1i}^{\frac{\sigma-1}{\sigma}} + \Sigma_{i=1}^{n_1^*} x_{1i}^{*\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad \alpha > 1$$

This yields demand functions similar to those in the first model, the only difference being that β percent of the expenditures is spent on x_1 and (1-β) percent of the expenditure is spent on x_2. In fact, the first model is just a special case of this model where β=1.

$$x_{1i} = \frac{p_{1i}^{-\sigma}}{\Sigma_{j=1}^{n_1} p_{1j}^{1-\sigma} + \Sigma_{j=1}^{n_1^*} q_{1j}^{*1-\sigma}} (\beta E)$$

$$x_{1i}^* = \frac{q_{1i}^{*-\sigma}}{\Sigma_{j=1}^{n_1} p_{1j}^{1-\sigma} + \Sigma_{j=1}^{n_1^*} q_{1j}^{*1-\sigma}} (\beta E)$$

The profit functions for good x_1 are virtually unchanged from before, yielding similar results.

Profit for firm i of home country producing x_i is:

$$\pi_{1i} = x_{1i}(p_{1i} - c) - f$$

FOC: $p_{1i} = \frac{\sigma}{\sigma-1} a_{x_1} w$

Profit for firm i of the foreign country producing x_i^* is:

$$\pi_{1i}^* = x_{1i}^*(p_{1i}^* - c^*) - f^*$$

FOC: $p_{1i}^* = \frac{c^*}{\frac{\sigma-1}{\sigma}} = \frac{\sigma}{\sigma-1} a_{x_1}^* w^*$

The maximized profit equations and the equilibrium output of the representative firm differ only in our taking into account that β percent of the expenditure is spent on the differentiated goods x_1.

$$\pi_1 = \frac{(a_{x_1} w)^{1-\sigma}}{n_1 (a_{x_1} w)^{1-\sigma} + n_1^* (a_{x_1}^* w^* (1+t_1))^{1-\sigma}} \left(\frac{\beta E}{\sigma}\right) - b_{x_1} w$$

The effect of changing parameter values on variables

Calibration values: $a_{x1} = 5$, $a^{*}_{x1} = 5$, $a_N = 16$, $b_{x1} = 20$, $b^{*}_{x1} = 20$, t1= 0, sigma = 2, L = 10000, $L^{*} = 8000$

Changed parameters	n_1	% change in n_1	n^{*}_1	% change in n^{*}_1	N	% change in N
None	50		200		500	
t=0.01	51.98	3.96	200	0	495.05	-0.99
t=0.05	59.52	19.05	200	0	476.19	-4.76
t=0.1	68.18	36.36	200	0	454.55	-9.09
s=3 and t=0	33.33		133.33		500	
s=3 and t=0.1	45.45	36.36	133.33	0	454.55	-9.09

	w	% change in w	w^{*}	% change in w^{*}	Utility	% change in Utility
None	0		0		250,000	
t=0.01	9.92E-05	-0.79	9.82E-05	-1.77	253,976	1.59
t=0.05	9.63E-05	-3.67	9.17E-05	-8.26	269,410	7.76
t=0.1	9.32E-05	-6.78	8.47E-05	-15.25	287,686	15.07
s=3 and t=0	0		0		17,212.2	
s=3 and t=0.1	9.32E-05	-6.78	8.47E-05	-15.25	19,124.8	11.11
t=10					745,868	198.35
t=10.01					745,925	198.37

$$x_1 = \frac{(a_{x_1} w)^{-\sigma}}{n_1 (a_{x_1} w)^{1-\sigma} + n_1^{*} (a_{x_1}^{*} w^{*} (1+t_1))^{1-\sigma}} \left(\frac{\sigma-1}{\sigma}\right)(\beta E)$$

$$\pi_1^{*} = \frac{(1+t_1)^{-\sigma} (a_{x_1}^{*} w^{*})^{1-\sigma}}{n_1 (a_{x_1} w)^{1-\sigma} + n_1^{*} (a_{x_1}^{*} w^{*} (1+t_1))^{1-\sigma}} \left(\frac{\beta E}{\sigma}\right) - b_{x_1}^{*} w^{*}$$

$$x_1^{*} = \frac{\left[\left(\frac{\sigma}{\sigma-1}\right)(a_{x_1}^{*} w^{*} (1+t_1))\right]^{-\sigma}}{\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \left[n_1 (a_{x_1} w)^{1-\sigma} + n_1^{*} (a_{x_1}^{*} w^{*} (1+t_1))^{1-\sigma}\right]} (\beta E)$$

$$C_2 = \left(\sum_{i=1}^{n_2^{*}} x_{2i}^{*\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}} \qquad \varepsilon > 1$$

where x^{*}_{2i} is the quantity of the i'th foreign produced variety of good x_2, n^{*}_2 is the number of product varieties of good x_2 made in the foreign country, and ε is the elasticity of substitution between any two products. It can be shown that for such a utility function, demand takes the form:

$$x_{2i}^{*} = \frac{q_{2i}^{*-\varepsilon}}{\sum_{j=1}^{n_2^{*}} q_{2j}^{*1-\varepsilon}} (1-\beta) E$$

The representative firm's profit equation is:

$$\pi^*_{2i} = x^*_{2i}(p^*_{2i} - c^*_2) - f^*_2$$

To maximize its profits, the firm sets marginal revenue equal to marginal cost.

FOC: $p^*_{2i} = \frac{\varepsilon}{\varepsilon-1} c^*_2 = \frac{\varepsilon}{\varepsilon-1} a^*_{x_2} w^*$

As before, we will make the traditional assumption that each type of differentiated product is supplied by a single firm, and that each firm supplies only one product type. We will also assume that all firms in a particular country are symmetric such that:

$$p^*_{21} = p^*_{22} = \ldots = p^*_{2n^*_2} = p^*_2$$

Given these assumptions, we can now estimate the maximized profit for the representative firm.

$$\pi^*_2 = \frac{q_2^{*-\varepsilon}}{n^*_2 q_2^{*1-\varepsilon}}(1-\beta)E\left(p^*_2 - a^*_{x_2} w^*\right) - b^*_{x_2} w^*$$

$$\pi^*_2 = \frac{\left(p_2^{*1-\varepsilon} - a^*_{x_2} w^* p_2^{*-\varepsilon}\right)(1+t_2)^{-\varepsilon}}{n^*_2 p_2^{*1-\varepsilon}}(1-\beta)E - b^*_{x_2} w^*$$

$$\pi^*_2 = \frac{\left[\left(\frac{\varepsilon}{\varepsilon-1}\right) a^*_{x_2} w^*\right]^{1-\varepsilon} - a^*_{x_2} w^* \left[\left(\frac{\varepsilon}{\varepsilon-1}\right) a^*_{x_2} w^*\right]^{-\varepsilon} (1+t_2)^{-\varepsilon}}{n^*_2 \left[\left(\frac{\varepsilon}{\varepsilon-1}\right)\left(a^*_{x_2} w^*(1+t_2)\right)\right]^{1-\varepsilon}}(1-\beta)E - b^*_{x_2} w^*$$

Simplification of the above equation yields the following maximized profit equation for the representative firm:

$$\pi^*_2 = \frac{1}{n^*_2(1+t_2)}\left(\frac{1-\beta}{\varepsilon}\right)E - b^*_{x_2} w^*$$

We can also compute the representative firm's output of x^*_2:

$$x^*_2 = \frac{1}{n^*_2 a^*_{x_2} w^*(1+t_2)}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E$$

We are still assuming that the zero profit condition holds such that the three maximized profit equations, linked to the zero profit condition yield three of the general equilibrium conditions.

We can now add the new labor market equilibrium conditions.

The home country sells N units of the numeraire commodity at marginal cost in the foreign country: $p_N = a_N w$

The home country's labor equilibrium is:

$$n_1 a_{x_1} x_1 + n_1 b_{x_1} + a_n N = L$$

The foreign country's labor equilibrium is:

$$n^*_1 a^*_{x_1} x^*_1 + n^*_1 b^*_{x_1} + n^*_2 a^*_{x_2} x^*_2 + n^*_2 b^*_{x_2} = L^*$$

Finally, we add the balanced trade condition. The value of imports has to equal the value of exports:

$$p_N N = (n^*_1 p^*_1 x^*_1) + (n^*_2 p^*_2 x^*_2)$$

The three maximized profit equations, the labor market equations, and the balanced trade equation define the general equilibrium. However, as in the previous model, the latter three equations in their current form cannot be used to solve for the variables of the problem.

By substituting x_1, x^*_1, x^*_2, p^*_1, p^*_2, and p_N by their corresponding values in the above equations, we get the six equations which allow us to express the general equilibrium conditions in terms of the parameters of the model.

$$\frac{n_1 a_{x_1}\left(a_{x_1} w\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n^*_1\left(a^*_{x_1} w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)(\beta E) + n_1 b_{x_1} + a_n N = L$$

$$\frac{n^*_1 a^*_{x_1}\left(a^*_{x_1} w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n^*_1\left(a^*_{x_1} w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)(\beta E) + n^*_1 b^*_{x_1} + \frac{n^*_2 a^*_{x_2}}{n^*_2 a^*_{x_2} w^*(1+t_2)}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E + n^*_2 b^*_{x_2} = L^*$$

$$\frac{n^*_1 a^*_{x_1}\left(a^*_{x_1} w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n^*_1\left(a^*_{x_1} w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)(\beta E) + n^*_1 b^*_{x_1} + \frac{1}{w^*(1+t_2)}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E + n^*_2 b^*_{x_2} = L^*$$

$$a_N wN = \left(\frac{\sigma}{\sigma-1} \frac{n_1^* a_{x_1}^* w^* \left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}} \left(\frac{\sigma-1}{\sigma}\right)(\beta E) \right) + n_2^* \frac{\varepsilon}{\varepsilon-1} a_{x_2}^* w^* \frac{1}{n_2^* a_{x_2}^* w^*(1+t_2)} \left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E$$

$$a_N wN = \left(\frac{n_1^*\left(a_{x_1}^* w^*\right)^{1-\sigma}(1+t_1)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1-t_1)\right)^{1-\sigma}}(\beta E) \right) + \frac{1}{(1+t_2)}(1-\beta)E$$

As before, we chose E to be our numeraire, and we set E = 1.

We can now write the six equations which allow us to obtain the general equilibrium. We first have the three maximized profit equations with the zero profit condition:

$$\pi_1 = \frac{\left(a_{x_1} w\right)^{1-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\beta E}{\sigma}\right) - b_{x_1} w = 0$$

$$\pi_1^* = \frac{(1+t_1)^{-\sigma}\left(a_{x_1}^* w^*\right)^{1-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\beta E}{\sigma}\right) - b_{x_1}^* w^* = 0$$

$$\pi_2^* = \frac{1}{n_2^*(1+t_2)}\left(\frac{1-\beta}{\varepsilon}\right)E - b_{x_2}^* w^* = 0$$

Then we have the respective home and the foreign labor market equations:

$$\frac{n_1 a_{x_1}\left(a_{x_1} w\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)(\beta E) + n_1 b_{x_1} + a_n N = L$$

$$\frac{n_1^* a_{x_1}^*\left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}\left(\frac{\sigma-1}{\sigma}\right)(\beta E) + n_1^* b_{x_1}^* + \frac{1}{w^*(1+t_2)}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E + n_2^* b_{x_2}^* = L^*$$

Finally, we have the equation representing the balanced trade condition:

$$a_N wN = \left(\frac{n_1^*\left(a_{x_1}^* w^*\right)^{1-\sigma}(1+t_1)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}}(\beta E) \right) + \frac{1}{(1+t_2)}(1-\beta)E$$

We can now solve for n, n^*_1, n^*_2, N, w, and w^*.

Given our interest in studying the welfare consequences of tariff changes, we can also express the original utility function in terms of the parameters of the model:

$$U = C_1^{\beta} C_2^{1-\beta}$$

$$C_1 = \left[\Sigma_{i=1}^{n_1} x_{1i}^{\frac{\sigma-1}{\sigma}} + \Sigma_{i=1}^{n_1^*} x_{1i}^{*\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

$$C_1 = \left[n_1 x_1^{\frac{\sigma-1}{\sigma}} + n_1^* x_1^{*\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

$$C_1 = \left[n_1 \left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(\beta E)\left(a_{x_1} w\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}} \right]^{\frac{\sigma-1}{\sigma}} + n_1^* \left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(\beta E)\left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}} \right]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

$$C_2 = \left(\Sigma_{i=1}^{n_2^*} x_{2i}^{*\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

$$C_2 = n_2^{*\frac{\varepsilon}{\varepsilon-1}} x_2^*$$

$$C_2 = n_2^{*\frac{\varepsilon}{\varepsilon-1}} \frac{1}{n_2^* a_{x_2}^* w^*(1+t_2)}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E$$

$$U = \left[n_1 \left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(\beta E)\left(a_{x_1} w\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}} \right]^{\frac{\sigma-1}{\sigma}} + n_1^* \left[\frac{\left(\frac{\sigma-1}{\sigma}\right)(\beta E)\left(a_{x_1}^* w^*(1+t_1)\right)^{-\sigma}}{n_1\left(a_{x_1} w\right)^{1-\sigma} + n_1^*\left(a_{x_1}^* w^*(1+t_1)\right)^{1-\sigma}} \right]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\beta\sigma}{\sigma-1}} \left[\frac{n_2^{*\frac{1}{\varepsilon-1}}\left(\frac{\varepsilon-1}{\varepsilon}\right)(1-\beta)E}{a_{x_2}^* w^*(1+t_2)} \right]^{1-\beta}$$

Effect of different values on variables

Calibration values: ax1=5,a^*_{x1}=5,a^*_{x2}=5, a_N=16,b_{x1}=20, b^*_{x1}=20, t_1=0, t_2=0. sigma=2, epsilon=0, L=10,000, L^*=8,000

Changed parameters	n1	% change in n1	n*1	% change in n*1	n*2	% change in n*2	N	% change in N
None	50		75		125		500	
t1=0	68.18	36.36	59.52	-20.64	140.48	12.38	454.55	-9.09
t2=.0.1	50	0	80.95	7.94	119.05	-4.76	500	0

	w	% change in w	w*	% change in w*	Utility	% change in utility
None	0.0001		0.0001		62,500	
t1=0.1	9.8E-0.5	-2.12	8.9E-05	-11.02	71,758.3	14.81
t2=0.1	9.5E-05	-4.55	9.5E-05	-4.55	62,358.4	-0.23

Once again, there are no closed form solutions to the general equilibrium.

As we can see from the above data, for all the tested parameters,[9] an increase in the tariff on the differentiated products made both abroad and locally increases n_1, decreases n^*_1, increases n^*_2, decreases w, decreases w^*, and increases utility. The change from our "traditional" model comes from the decrease in n^*_1 and the increase in n*2. In our traditional model, n^*_1 was fixed because it was the only product made by the foreign country. Now, the decrease in the price resulting from the home country's tariff leads to the exit of firms from this differentiated goods production sector and to the entry of firms in the other differentiated goods sector in the foreign country. As a result, the price of one unit of x^*_1 does not fall as much as it did before (for example the nominal wage falls by 11 percent for a tariff of 10 percent rather than the 15 percent decrease previously observed). The increase in home production of x_1 is the same as in the previous model. Overall, the number of varieties of x_1, increases but by less than in the first model. Utility does not increase as much as before; home consumers now pay more than in the other model for an equivalent tariff on the foreign variety. The decrease in n^*_1 probably does not affect utility much because it is compensated by an increase in n^*_2.[10] For instance, for a tariff rate of 10 percent, home country utility increases by 14.83 percent versus the previous increase of 15.07 percent. Of course, the same flaws that put an upward bias on the effect of a tariff in our "traditional" model still afflict this model. For all the tested parameters, an increase in the tariff rate on the differentiated products made exclusively abroad does not affect n_1, increases n^*_1, decreases n^*_2, does not affect N, decreases w, decreases w^*, and decreases utility. Since the home country does not produce x_2, its producers are unaffected by the tariff on the imports of x_2. By decreasing the profits of the foreign makers of differentiated products x_2, the tariff makes it unprofitable for firms to produce x_2. Firms will exit until the zero profit condition is reestablished. This results in the entry of foreign firms in the sector producing x_1. The shift has a negative effect on utility but the effect is much more restricted than the one in the Romer model because the drop in the number of varieties of x_2 is compensated by the increase in the number of varieties of x_1. For instance, we estimated that a 10 percent tariff decreases utility by only 0.23 percent. This is also the reason we said that the changes in n^*_1 and n^*_2 in the first model had little effect on utility.

The model's flaw comes from the exaggerated importance of tariffs on x_1 which minimize the effects of tariffs on x_2. For instance, a tariff rate of 50% on imports of x_2 only decreases utility by 4%. However, the model remains useful because it indicates the direction of the changes in utility resulting from tariffs. First of all, it confirms our intuition that putting a tariff on the differentiated goods made only abroad decreases utility. This also confirms that installing a tariff on the differentiated goods produced both abroad and domestically increases utility. The results of a tariff on both x_1 and x_2 actually differs. For some values of t_1 and t_2, welfare increased by more than when only t_1 was positive ($t_1 = 0.1$ and $t_2 = 0.1$ is such an example). For other values, the increase in welfare was smaller than the simple summing of the increases in welfare due to a tariff on x_1 and a decrease due to a tariff on x_2. For most values, however, the welfare effect is simply between the increase due to t_1 and the decrease due to t_2. When both tariffs are installed, they influence n^*_1 and n^*_2 in different directions, and the balance of those influences results in the changes we have observed. In more sophisticated models correcting for our overestimates, a tariff on x_2 might actually be able to counter the increase in utility resulting from the tariff on t_1; since we have not actually observed this phenomenon, however, we can only speculate.[11] Though we cannot realistically quantify the actual effects of tariffs on welfare from our model, knowing the mere direction of those effects is important. We have found that the "traditional" models usually overestimate the effects of tariffs when they ignore one way trade in differentiated products, so we ought to find the argument for welfare improving tariffs less convincing. This result is important in the current political climate where rent seekers tend to use untenable arguments to claim a tariff would be welfare improving in order to secure the benefits of a tariff for themselves at the expense of domestic consumers. In a similar vein, we have found that we cannot accept the conclusions of a model uncritically because simple changes in its parameters and assumptions can lead to utterly different conclusions. As such, we know to question any unqualified economic judgment in both the realms of political debate and technical microeconomics.

[1] Two examples of such models are: Gros, Daniel. "A Note on the Optimal Tariff, Retaliation, and the Welfare Loss from Tariff Wars in a Framework of Intra-Industry Tarde." *Journal of International Economics.* 23, 1987: 367-381. Helpman, Elhanan and Paul Krugman. *Trade Policy and Market Structure.* Cambridge, Mass.: MIT Press, 1989: 130-139.

[2] Venables, Anthony J. "Trade and Trade Policy with Differentiated Products: A Chamberlinian Ricardian Model." *The Economic Journal.* Sep- tember, 1987: 700-717.

[3] Romer, Paul. "New Goods, Old Theory and the Welfare Costs of Trade Restrictions." *Journal of Development Economics.* 43, 1994: 5-38.

[4] In case this is not clear in the above text, the i'th home produced variety of good x_1 is a different variety than the i'th foreign produced variety of good x_1.

[5] Dixit, Avinash K., and Joseph E. Stiglitz. "Monopolistic Competition and Optimum Product Diversity." *The American Economic Review.* No. 3, 1977: 297-298.

[6] This argument is similar to the one presented in Grossman, Gene M., and Elhanan Helpman. *Innovation and Growth in the Global Economy.* Cambridge: The MIT Press, 1991: 28.

[7] Mathematica 2.22 from Wolfram Research was used to solve the equations.

[8] Several values of sigma between 1.5 and 5 were tested. L and L^* were tested for values between 1000 and 25000 with varying values for $(L-L^*)$. L must be greater than L^* for all the variables to have positive values. Different values of a_{x1}, a^*_{x1}, a_N, b_{x1} and b^*_{x1} were used, all varying from 1 to 20.

[9] The same values for the parameters which were used before were again tested. In addition, values of epsilon between 1.5 and 5 were used in all of the computations, t_2 was tested for values between 0 and

10, and for a^*_{x2} and b^*_{x2} values between 1 and 20 were used.

[10] The explanation for this is the same as the explanation presented for the effect of t_2 on these two same parameters. See next page.

[11] Actually, if we set a sufficiently small e and a sufficiently large s (for instance 1.5 and 5 respectively), the decrease in welfare from a tariff on x_2 is greater than the increase in welfare due to the tariff on x_1. However, there is no reason to believe that the elasticity of substitution would be so much larger for differentiated products made both locally and abroad.

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