E C O N O M I C S B U L L E T I N

Trade liberalization, consumption externalities and the environment

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Abstract

It has conventionally been argued that trade liberalization will degrade the environment of a country that imports a good whose consumption gives rise to pollution. By contrast, this note demonstrates that, if the linkage between the trade and the environmental policies has been taken into consideration, then liberalizing trade in a good that generates consumption−type negative externalities will actually improve the environment of the importing country.

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1. Introduction

The impact of trade liberalization on the environment has become the focus of much attention and debate. Opponents of trade liberalization fear that the expansion of consumption and production activities that result from trade liberalization will result in a worsening of the environment.[1] Previous studies such as Anderson (1992) have shown that liberalizing trade in a good whose consumption gives rise to pollution will cause a country's environment to deteriorate if the good is imported. Such environmental degradation associated with international trade appears to make trade liberalization less attractive.

When analyzing the environmental effects of trade liberalization, Anderson (1992) assumes that environmental regulations are exogenously fixed. However, environmental regulations are expected to react to changes in trade policies. The aim of this note is to demonstrate that if the linkage between the environmental and the trade policies has been considered, then a tariff reduction in a country importing a good whose consumption gives rise to pollution will improve that country's environment. Our argument makes trade liberalization more desirable from the point of view of environmental protection.

To this end, we construct a trade model with an imperfectly competitive product market. A Home firm and a Foreign firm produce a homogeneous good and compete in the Home market. All of the Home firm's output is sold in the domestic market, and none is exported. Consumption of the good in question gives rise to pollution. An environmental tax is imposed on the dirty good, and the imported items are subject to a tariff as well.

The major finding of this note is that an exogenous reduction in the tariff on the dirty good will improve the importing country's environment. As we will demonstrate, the environmental tax increases as the tariff rate decreases. Such a linkage effect of tariff reduction that tightens the environmental regulation will outweigh the direct effect of tariff reduction, and thus pollution will be reduced as a result of trade liberalization.

There is now an extensive literature on the environmental effects of trade liberalization (see Schulze and Ursprung (2001) for a comprehensive survey). Most of the literature only considers negative externalities associated with production,[2]

[1] Proponents of free trade in turn argue that trade *per se* is not a direct cause of environmental problems. To efficiently protect the environment, governments should adopt environmental policies rather than trade policies. See Anderson and Blackhurst (1992).

[2] See, for example, Markusen (1975), Copeland (1994), and Burguet and Sempere (2003), among others.

but here we shall deal with negative externalities associated with consumption.[3] In considering consumption-type pollution, Krutilla (1991) focuses attention on the determination of environmental regulations, and disregards the effects of trade liberalization on pollution control, which is the focus of this note. Bommer and Schulze (1999), Fredriksson (1999) and Damania, *et al.* (2003) discuss the impact of tariff reductions on the environment within the framework of political economy, whereas this note makes reference to a benevolent government that seeks to maximize national welfare.

2. The Model

There are two countries, Home and Foreign, with each having one firm producing a homogeneous product. Foreign variables are denoted by an asterisk (*). The sales of the Home firm and the Foreign firm are denoted by q and q^*, respectively.

We assume that all consumers in the Home country are identical, and normalize the size of the population in the Home country to one. The representative consumer derives utility from consuming the good under consideration, as well as a competitive-produced numeraire good, and suffers from consumption-type pollution. The utility function of the representative consumer in the Home country is given by:

$$U = u(q, q^*)+m-\theta(q+q^*) = \alpha(q+q^*)-(q^2+2qq^*+q^{*2})/2+m-\theta(q+q^*),\ \alpha > 0 \quad (1)$$

where m is the consumption of the numeraire good, and θ is the coefficient of the marginal pollution damage. When making the consumption decisions, the representative consumer is assumed to ignore the negative externality. Then, by solving the optimization problem of the Home consumer, we can derive the domestic demand function for the good in question, which is given by:

$$p = \alpha - (q + q^*)$$

where p denotes the price of the good. We assume that α is greater than θ.[4]

[3]The distinction between the consumption and production externalities is crucial. Anderson (1992) has shown that a lowering of the tariff on a good whose production gives rise to pollution will improve the importing country's environment, which is quite different from the case of consumption externalities.

[4]If $\theta > \alpha$, it means that the marginal damage from the dirty consumption is greater than the marginal utility from dirty consumption, which is equal to $\alpha - q - q^*$. We rule out this situation. In addition, when ignoring the pollution damage costs, satiation will set in with the utility function at $\alpha = q + q^*$. If $q + q^* > \alpha$, then the marginal utility of consumption is negative. We assume that α is sufficiently large to prevent this from happening.

The consumption of the good under consideration gives rise to negative externalities; SO_2 emissions associated with home heat consumption is an example of consumption-type externalities. We assume that the consumption pollution does not affect firms' production and does not spill over to other countries. In order to protect the environment, the Home country levies an environmental tax on the polluting good. This environmental tax is non-discriminatory, so that both the imported and domestic-made goods are subject to the same environmental tax rate.[5] In addition to the environmental charge, the Home country levies a tariff on imported items. Tax revenues are distributed in the form of a lump sum to the consumer.

For simplicity, we assume that the output of the Home firm is not exported overseas.[6] The Home firm's total profit is thus given by:

$$\pi = (p - c - t)q \tag{2}$$

where t denotes the environmental tax, and c is the marginal production cost. The Foreign firm's total profit is:

$$\pi^* = (p - c^* - t - \tau)q^* \tag{3}$$

where τ is the tariff rate.

The two firms compete in terms of quantity. Under the Nash assumption, by substituting the demand function into both firms' objective functions, we can solve their first-order conditions:

$$\frac{\partial \pi}{\partial q} = \alpha - 2q - q^* - c - t = 0 \tag{4}$$

$$\frac{\partial \pi^*}{\partial q^*} = \alpha - 2q^* - q - c^* - t - \tau = 0 \tag{5}$$

The output levels under the Nash equilibrium are obtained by solving eqs.(4) and (5):

$$q = (\alpha - 2c + c^* - t + \tau)/3 \tag{6}$$

$$q^* = (\alpha + c - 2c^* - t - 2\tau)/3 \tag{7}$$

The comparative-static exercises reveal that an increase in t reduces both q and q^* by the same amount. The comparative-static results also show that a decrease in τ will increase q^* but decrease q. The decrease in q is less than the increase in q^*, and thus the total consumption in the Home country expands as τ decreases.

[5] In this situation, the environmental tax is equivalent to a consumption tax.

[6] If the Home market and the Foreign market are segmented, then allowing the Home firm's output to be exported will not change the following results.

3. The Environmental Tax

In this section, we discuss the determination of the environmental tax. The objective of the Home government is to maximize the social welfare function, which is defined as the summation of the consumer's surplus and the Home firm's profits, tax and tariff revenues and pollution costs. Thus, the Home country's social welfare function is given by:

$$\begin{aligned} W &= u(q,q^*) - pq - pq^* + \pi + t(q+q^*) + \tau q^* - \theta(q+q^*) \\ &= \alpha(q+q^*) - (q^2 + 2qq^* + q^{*2})/2 - pq^* - cq + (t+\tau)q^* - \theta(q+q^*) \end{aligned} \quad (8)$$

where $u(q,q^*) - pq - pq^*$ measures the consumer's surplus.

The Home government maximizes social welfare with respect to t, which yields the first-order condition:

$$\begin{aligned} \frac{\partial W}{\partial t} &= \underbrace{\frac{2}{9}[-2(\alpha - t) - c - c^* + \tau]}_{\Delta\,\text{consumer's surplus}} \underbrace{-\frac{2}{9}(\alpha - 2c + c^* - t + \tau)}_{\Delta\,\text{Home firm's profit}} \\ &\quad + \underbrace{\frac{1}{3}(2\alpha - c - c^* - 4t - \tau)}_{\Delta\,\text{environmental tax}} \underbrace{-\frac{\tau}{3}}_{\Delta\,\text{tariff}} + \underbrace{\frac{2\theta}{3}}_{\Delta\,\text{pollution}} = 0 \end{aligned} \quad (9)$$

Since $\partial^2 W/\partial t^2 = -2/3 < 0$, the second-order condition is satisfied.

The first-order condition can be solved for the second-best environmental tax as follows:

$$t = \theta - \tau + \frac{c - c^*}{2} \quad (10)$$

It is well known that in a closed economy with an imperfectly competitive product market, the second-best environmental tax is generally less than the Pigouvian tax.[7] This is because the optimal environmental tax should be set to balance pollution costs and the loss in the consumer's surplus due to market imperfections. In a model dealing with open economies like this one, in addition to considering pollution costs and the welfare loss associated with market imperfections, the government also employs the environmental tax to shift rents away from its trading partner. The presence of such a rent-shifting effect will increase the environmental tax, other things being equal. Thus, the second-best environmental tax in an open economy can be greater or less than the marginal pollution damage θ, depending on the relative strength of the rent-shifting effect and the welfare loss to the consumer

[7] See, e.g., Baumol and Oates (1988), Chap. 6 for more details. In addition, see Carraro, *et al.* (1996) for a discussion of various related issues.

resulting from a lower level of consumption.[8]

Since our main concern is the effect of trade liberalization on the environmental regulation, which in turn has an environmental effect, we have briefly discussed the disparity between the second-best environmental tax and the Pigouvian tax as in the above.[9] We now turn to our major concern by examining the effect of a tariff reduction on the environmental tax.

Equation (9) reveals that the effects of a tariff reduction on the environmental tax can be broken down into a number of effects. First, a tariff reduction will induce a larger amount of q^*. In this situation, an increase in t will result in a larger welfare loss to the consumer, making the government more reluctant to restrict the environmental regulation. The first term of eq.(9) describes this effect. Given the second-best environmental tax, differentiating the first term of eq.(9) with respect to τ yields $2/9$, which indicates that $\partial \mathrm{CS}/\partial t$ is increasing with τ, where CS denotes the consumer's surplus. Since $\partial \mathrm{CS}/\partial t$ is less than zero,[10] the positive relation between $\partial \mathrm{CS}/\partial t$ and τ means that an increase in t will result in a larger amount of welfare loss to the consumer as the tariff is reduced.

Second, at a lower tariff rate, the foregone tariff revenues resulting from raising the environmental tax are reduced. This effect is presented by the fourth term of eq.(9). Thus, the government will set a higher environmental tax, when its opportunity costs in terms of foregone tariff revenues from increasing t are lower.

Third, as indicated by eqs.(6) and (7), a tariff reduction will give rise to a larger amount of q^* and a higher ratio of $q^*/(q+q^*)$, which provide the government with a stronger incentive to raise t in order to shift rents away from the Foreign firm. This effect is reflected by the third term of eq.(9), which is equal to $\partial \mathrm{ET}/\partial t$, where ET denotes the environmental tax revenues. We assume that the Home country is located on the upward-sloping part of the Laffer curve. Thus, the environmental tax revenues increase with t, so that the third term of eq.(9) is greater than zero. Given the second-best environmental tax, differentiating the third term of eq.(9) with respect to τ yields $-1/3$, which indicates that $\partial \mathrm{ET}/\partial t$ is decreasing with τ. This demonstrates that when the tariff is reduced, a marginal increase in t brings

[8] In a more general model, the optimal environmental tax can be expressed as the summation of the marginal pollution damage and adjusted terms, which reflect the welfare loss to the consumer associated with the market imperfections and the rent-shifting effect, respectively. Unfortunately, all the adjusted terms are mixed together in eq.(10). This is a restriction of using specific functional forms.

[9] Whether the second-best environmental tax is greater or less than the Pigouvian tax does not change the results that follow.

[10] By substituting the optimal environmental tax (eq.(10)) into the first term of eq.(9), we obtain $\partial \mathrm{CS}/\partial t = 2[-2\alpha + 2\theta - 2c^* - \tau]/9$. Since α is greater than θ, we have $\partial \mathrm{CS}/\partial t < 0$.

about more tax revenues, and thus shifts more rents away from the Foreign firm.

Finally, the second term of eq.(9) measures the impact of changing t on the Home firm's profit. We find that $|\partial\pi/\partial t|$ decreases as τ decreases, which indicates that trade liberalization reduces the environmental tax's adverse impact on the Home firm's profit. As indicated before, a tariff reduction will increase the total consumption in the Home country, and thus depress the price of the dirty good. A lower p will reduce $|\partial\pi/\partial t|$. With a lower $|\partial\pi/\partial t|$, the Home government is more willing to raise t.

In sum, when the Home country's tariff decreases, the welfare loss to the consumer induces the government to levy a lower t, whereas the other three effects lead to a higher t.[11] Equation (10) reveals that the environmental tax increases as a consequence of a tariff reduction, which implies that the other three effects outweigh the welfare loss to the consumer.[12]

4. The Effects of Trade Liberalization

Now we turn to the effects of trade liberalization. In this note, the term "trade liberalization" is used merely in the sense of a reduction in a tariff barrier. Here we assume that the Home country is subject to an international agreement, and is forced to decrease its tariff. The total effect of trade liberalization on pollution consists of two components: the direct effect and the linkage effect, which can be described by the following equation:

$$\frac{d\,\theta(q+q^*)}{d\tau} = \underbrace{\frac{\partial\theta(q+q^*)}{\partial\tau}}_{(-)} + \underbrace{\frac{\partial\theta(q+q^*)}{\partial t}\frac{dt}{d\tau}}_{(+)} = \frac{\theta}{3} \tag{11}$$

The first term in the middle part of eq.(11) measures the direct effect, which is negative. The second term reflects the linkage effect, which is positive.

If the environmental tax does not change with the tariff, then only the direct effect presents itself and a decrease in the tariff increases the total consumption of the dirty good and therefore increases pollution. This corresponds with the conventional

[11] The above analysis does not discuss the effect of trade liberalization on the marginal pollution effect of changing t. This is because the last term of eq.(9) reveals that the marginal pollution effect of changing t is independent of τ. This property is related to the constant marginal pollution damage. If the marginal pollution damage increases with the total consumption, then a reduction in τ will increase the total consumption and total pollution, which in turn will induce the government to levy a higher environmental tax rate.

[12] Alternatively, we can obtain the same result from the following comparative-static exercise: $dt/d\tau = -(\partial^2 W/\partial t\partial\tau)/(\partial^2 W/\partial t^2)$. Since $\partial^2 W/\partial t^2$ and $\partial^2 W/\partial t\partial\tau$ are less than zero, $dt/d\tau$ is less than zero as well.

concept that a tariff reduction in a good whose consumption gives rise to pollution will deteriorate the importing country's environment. When the linkage effect of a tariff reduction is considered, a decrease in the tariff will tighten the environmental regulation, which will offset the pollution caused by the decrease in the tariff. Equation (11) shows that the linkage effect outweighs the direct effect. An increase in t reduces both q and q^*, whereas an increase in τ reduces q^* but increases q, and thus the consumption-restriction effect of the environmental tax is greater than that of the tariff. This result is consistent with the empirical finding provided by Wilson, *et al.* (2003), who state that the trade-restrictive effects of environmental regulations are stronger than those in relation to tariff barriers.

Thus we arrive the following proposition:

Proposition: *In an open economy with a linear demand, constant marginal production and pollution costs, and in which firms compete in terms of quantity, a tariff reduction in the Home country will reduce the pollution damage associated with consumption.*

5. Conclusion

The conventional wisdom assumes that trade liberalization will degrade the environment of a country that imports a dirty good whose consumption gives rise to pollution. This note by contrast demonstrates that, if the linkage between the trade and the environmental policies has been taken into consideration, then liberalizing trade in a good that generates consumption-type negative externalities will actually improve the environment of the importing country. This follows as a result of the reverse relationship between the environmental tax and the tariff, which is also due to the dominant linkage effect of trade liberalization that tightens the environmental regulation. Therefore, this finding is in line with the view that trade liberalization and environmental protection are compatible, rather than in conflict, with each other.

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