Does Trade Liberalization Increase Global Pollution?

Hamid Beladi,
Department of Economics,
University of Texas at San Antonio,
San Antonio, TX 78249, USA
Email: hamid.beladi@utsa.edu
Tel: 210-458-7038

Reza Oladi
Department of Applied Economics
Utah State University

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Hamid Beladi [*]

Depatment of Economics

University of Texas at San Antonio

Reza Oladi

Department of Applied Economics

Utah State University

Abstract

This note considers a simple duopoly market in which a domestic firm and a foreign firm use labor to produce an identical product and supply it to the domestic market. Firms emit pollution as a by-product of production. We show the conditions under which international trade liberalization decreases (increases) the global pollution.

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[*]Address for correspondence: Hamid Beladi, Department of Economics, University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas 78249-0633, Tel: 210-458-7038, Fax: 210-458-7040, Email: hamid.beladi@utsa.edu

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Abstract

This note considers a simple duopoly market in which a domestic firm and a foreign firm use labor to produce an identical product and supply it to the domestic market. Firms emit pollution as a by-product of production. We show the conditions under which international trade liberalization increases (decreases) the global pollution.

JEL: F1

Keywords: Trade liberalization, global pollution

1 Introduction

The environmental impact of trade liberalization has been a point of contention between advocates of free trade and environmental activists. Although the literature on trade and the environment can be traced back to work of Baumol (1971), it has been growing rapidly only in the past couple of decades or so. In a major strand of this literature the effect of international trade on environmental quality has been studied, see for example Pething (1976), Lopez (1994), Anderson and Blackhurst (1992), Copeland and Taylor (1994), Khan (1996), Batabyal (2000, 2002), and Chao and Yu (2004, 2007).[1] A fundamental assumption of these papers is perfect competitive markets.

The purpose of this note is to assume imperfect competitive market and investigate the effects of trade liberalization on the environment. As it has been established over the past few decades that many markets are not perfectly competitive, it is paramount to study the relationship between trade liberalization and environmental degradation when good markets are imperfectly competitive. We assume a simple production structure where labor and pollution are used as inputs. Put differently, emission is a by-product of production. There are two firms, a domestic and a foreign firm. In the absence of any other restriction on pollution, we consider the effects of a reduction in trade barriers on the domestic, foreign, and global pollution. Surprising and interestingly, we show as our main

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[1]See also McGuire (1982), Grossman and Krueger (1993), Mani and Wheeler (1997), Benchekroun and Long (1998), Chao and Yu (2000), and Parkash and Khan (2001), among others.

result that a unilateral trade liberalization by the home country results in a reduction in global pollution if and only if the foreign production is sufficiently cleaner than domestic production. That is, merely cleaner foreign production is not enough for this to happen. As an appealing corollary, we indicate that trade liberalization which results in a foreign monopoly can improve the global environment. Our paper is also related to Kennedy (1994) whereby he indicated that the interaction between governments due to imperfect competitive global markets can result in inefficient pollution taxes.

2 The Model

Consider an industry with two firms, a domestic and a foreign firm, that produce an identical good and supply it to the domestic market only. Firms use labor and pollution in their production process. That is, pollution is a by-product of producing the good. The production technologies are given by:

$$q = \min\{\alpha L, \beta E\} \tag{1}$$

$$q^* = \min\{\alpha^* L^*, \beta^* E^*\} \tag{2}$$

where L, E are labor usage and pollution by-product, respectively, and α and β are constant. Moreover, we distinguish foreign variables and parameters by an asterisk. The market demand is given by:

$$P = P(Q) \tag{3}$$

where $P' < 0$, $P'' = 0$ and $Q = q + q^*$ is the global production. Finally, we assume that the government of the home country imposes a unit tariff of t.[2]

The profit functions for the domestic and foreign firms are given, respectively, by:

$$\pi = P(q + q^*)q - wL \tag{4}$$

$$\pi^* = [P(q + q^*) - t]q^* - w^* L^* \tag{5}$$

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[2]One can use a more complex model to draw our conclusion. We prefer our model with its simple production structure.

where w is the wage rate. For mathematical simplicity we assume that the wage rates in both countries are equal. This assumption has no bearing on our results. The firms face no (direct) regulation of emission. Nevertheless, the usual assumption of firm theory regarding input usage is assumed. That is, for any given output level, firms use the lowest input levels. The domestic firm faces the maximization problem $\max_{L,E} \pi(L, E; w)$ while the foreign firm's problem is $\max_{L^*,E^*} \pi^*(L^*, E^*; w)$. As input minimization implies that $\alpha L = \beta E$ and $\alpha^* L^* = \beta^* E^*$, the first order conditions for both firms are:

$$\alpha^2 L P'(\alpha L + \alpha^* L^*) + \alpha P(\alpha L + \alpha^* L^*) - w = 0 \tag{6}$$

$$\alpha^{*2} L P'(\alpha L + \alpha^* L^*) + \alpha^*[P(\alpha L + \alpha^* L^*) - t] - w = 0 \tag{7}$$

Recall that $w = w^*$. The above equations are implicit reaction functions stated in terms of labor usage for these firms. Let $L = \phi(L^*)$ and $L^* = \phi^*(L)$ be the reaction functions for the domestic firm and the foreign firm, respectively. By totally differentiating equations (6) and (7) we obtain that $d\phi/dL^* = -\alpha^*/2\alpha < 0$ and $d\phi^*/dL = -\alpha/2\alpha^* < 0$. To obtain the Nash equilibrium labor usage we solve equations (6) and (7). Therefore, the equilibrium output levels and the price follow immediately. Note that there always exists a tariff level that both firms produce positive levels of output at the Nash equilibrium, regardless of unit labor cost differential. Moreover, the usual stability requirement is met since $2\alpha^*/\alpha > \alpha^*/2\alpha$. As we are interested in Nash equilibrium pollution levels, we will cast this problem in terms of pollution levels in the next section.

3   Equilibrium Pollution

Let $E = \psi(E^*)$ and $E^* = \psi(E)$ be the reaction function for the domestic firm and the foreign firm. The input minimization stated in the previous section also implies that $dL = (\beta/\alpha)dE$ and $dL^* = (\beta^*/\alpha^*)dE^*$. These relationships, as well as the our characterization of the reaction functions stated in labor usage space, imply that $d\psi/dE^* = -\beta^*/2\beta < 0$ and $d\psi^*/dE = -\beta/2\beta^* < 0$. As in the previous section, the stability requirement is also met since $2\beta^*/\beta > \beta^*/2\beta$.

To see the effect of trade liberalization on emitting behavior of the foreign firm, totally differ-

entiate equation (7), casted in pollution space, with respect to E^* and t to get:

$$2\beta^{*^2} P'(\beta E + \beta^* E^*)dE^* - \beta^* dt = 0 \tag{8}$$

implying that $d\psi^*/dt = 1/[2\beta^* P'(.)] < 0$. We therefore have the following proposition.

Proposition 1. *Trade liberalization by the domestic country reduces (increases) pollution in the domestic (foreign) country, while it decreases (increase) the global pollution if and only if $\beta^* > 2\beta$ ($\beta^* < 2\beta$).*

The first part of this proposition is straightforward. A reduction in tariff will shift the reaction function for the foreign firm outward, resulting in an increase in the emission of the foreign firm and a reduction in the emission of the home firm. Essentially, liberalization increases the foreign firm's production and decrease domestic firm's production. Imports of the domestic country obviously increases. Thus, the domestic country substitute foreign production for the domestic production. The effect on the global pollution is less straightforward. One might, at the first glance, expect that the global pollution should increase. This is also the conclusion that is more often drawn in the literature assuming perfect competitive markets. However, this may not be the case and the outcome can be in contrast to the literature. The following corollary highlights the effect of market power on the global pollution.

Corollary 1. *Trade liberalization that leads to a global foreign monopolist reduces the global pollution if and only if the foreign technology is sufficiently cleaner than that of home (i.e., $\beta^* > 2\beta$).*

This may seem puzzling and perhaps paradoxical at the first glance. To see the seemingly puzzling aspect of this corollary, assume that both firms have identical technologies (i.e., both firms have the same pollution intensities). A monopolist produces less output than under the duopoly market. Thus, one may expect that the opposite of the above result should emerge because less global output leads to less global pollution. However, this argument is flawed. If technologies are identical, then at free trade, each firm produces half of the market and the global production is higher with free trade that with tariff-ridden equilibrium. Therefore, the scenario stated in the corollary never arises with identical technologies. For the market share to be higher for the foreign firm at free trade, it must be the case that the firm is more efficient, i.e., $\beta^* > \beta$. Even this

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latter condition is not sufficient for global production to fall with liberalization even though it results in higher market share for the foreign firm. We need a stronger efficiency condition: the global production falls as a result of liberalization if and only if $\beta^* > 2\beta$. Put it differently, let $\beta < \beta^* < 2\beta$, i.e., the foreign technology is cleaner than that of home, but not clean enough. Under this condition trade liberalization has two opposing effects on global pollution. On the one hand, the global output rises with liberalization that leads to more pollution. On the other hand, the home production will be substituted with cleaner foreign production which reduces the global pollution. However, the former outweighs the latter. Therefore, the overall global pollution rises with liberalization. Figure (1) depicts the the effect of the trade liberalization when the condition of the above corollary is met; i.e., the scenario under which trade liberalization leads to a global foreign monopolist and a reduction in global pollution. ψ is the reaction function for the home country. $\psi^{*'}$ (ψ^*) is the free trade (tariff ridden) reaction function for the foreign country. The global pollution is $E_T + E_T^*$ under tariff ridden equilibrium, while the level of global pollution with free trade is E_F^*.

<div align="center">

<u>Insert Figure 1</u>

</div>

4   Conclusion

We assumed an oligopoly market where a domestic and a foreign firm produce an identical output and sell it in the domestic economy. Both firms use labor in their production process and emit pollution as a by-product. Using this set up, we address the question of whether trade liberalization leads to an increase in global pollution. We showed that the global pollution can decrease as a result of trade liberalization policy by the domestic country.

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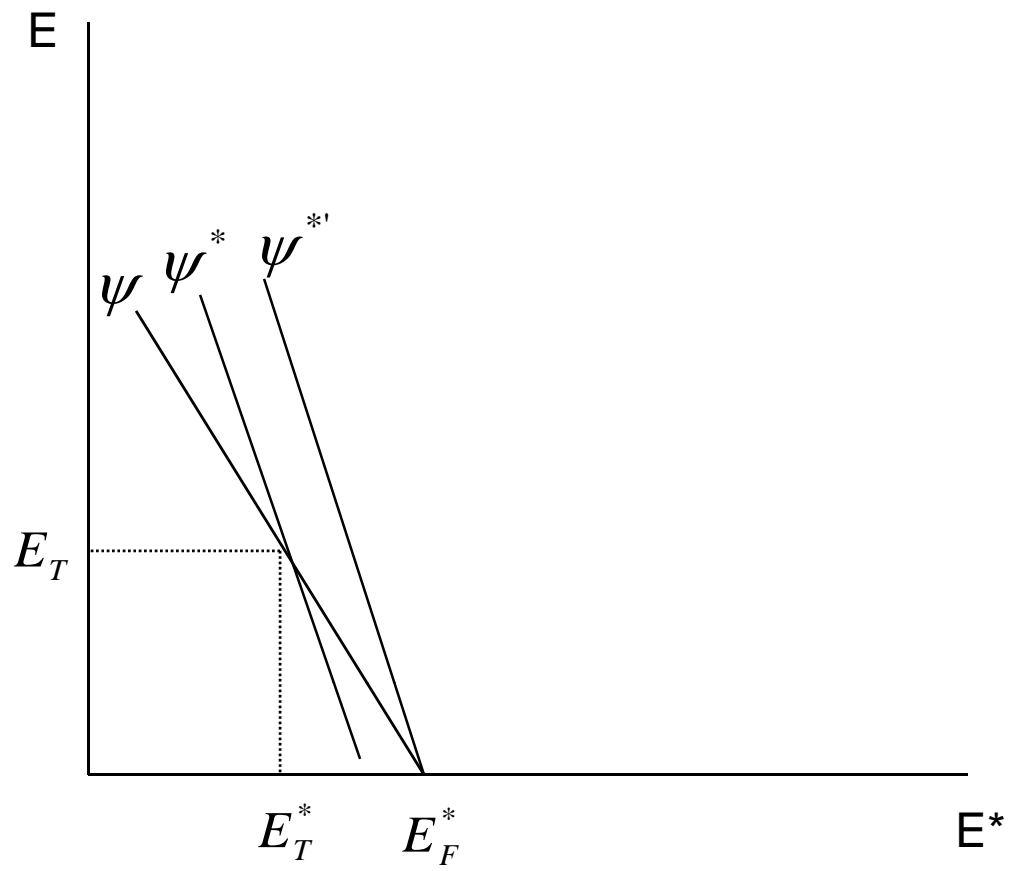
Figure 1: The effect of trade liberalization on global pollution