June 8, 2001

# Transboundary Pollution from Consumption in a Reciprocal Dumping Model*

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**Abstract**

We develop a reciprocal dumping type of model in which we analyse transboundary pollution and optimal tax policies. In our model there are two countries and two firms (one in each country). Each firm produces a homogeneous good to be consumed in both markets. The policy instruments available to the governments are a consumption tax and a tariff on the imports of that good. Pollution occurs during the consumption of goods by both societies. We show that both a uniform reduction and a revenue neutral reform can enhance welfare. Moreover, our results suggest that the conditions satisfying higher consumption taxes in a country also satisfy lower tariffs in that country.

**JEL Classification:** F1, H2
**Keywords:** Environment and Trade, Transboundary Pollution, Reciprocal Dumping

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* The authors are grateful to Sajal Lahiri for helpful comments on an earlier draft of the paper.

# 1 Introduction

The environmental issues that the economists deal with are two-fold. The first is resources, which are classified into two as renewable resources and non-renewable resources. Renewable resources are those capable of self-reproduction, such as fish and forest. Non-renewable resources (e.g., oil, coal) are the main source for the energy needs[1]. The second is pollution, which is the focus of this study. In particular, our aim is to analyse the transboundary pollution and trade relationship, and its policy implications.

As well as being a local problem, pollution may also be a transboundary or a global problem. Some local polluting activity that occurs once may have a little effect on the environment. However, if it takes place more often and repeatedly, then it would affect the environment globally. The greenhouse effect and depletion of ozone layer are well-known examples of this case[2]. Transboundary pollution is the movement of pollution across national boundaries. It is possible to divide the transboundary externalities into three categories[3]: (i) The pollution created during a production process may increase the production costs in other nations. For example, an industry disposing its wastes into a river may affect another industry in a down river nation; (ii) The pollution generated in production in one country may affect the environment of citizens in other countries (e.g., acid rains); (iii) Another category is the externalities caused by consumption or final use of goods. This may both increase the abatement costs and influence the environmental quality in other countries (e.g., importing and consuming a good that has a non-recyclable package).

The first two do not necessarily require trade for them to emerge, while the last

[1]The works in the literature of renewable resources can be seen in Lahiri and Muthoo (1996), Arnason (1990), Berck (1981), Pindyck (1984) etc. The works in the literature of non-renewable resources can be seen in Barnett and Morse (1963), Farzin (1992), Halvorsen and Smith (1991), Pindyck (1980).

[2]Greenhouse effect is the phenomenon whereby carbon dioxide and other gases trap long-wave infra-red radiation (heat) in the atmosphere, thereby warming the earth.

[3]See d'Arge (1975).

one occurs as a result of trade. Environmental regulations can be designed, either nationally or internationally, to overcome the above issues. Policies like tradable permits, consumption and production taxes, import taxes etc., aim to reduce consumption of dirty goods and thus achieve a specified target for global reduction in emission levels. Not only the environmental regulations but also trade policies can be targeted towards the environmental problems to achieve lower levels of pollution. However, more and more countries are attempting to use (or abuse) environmental concerns to protect domestic industries or to decrease the volume of imports, thus generating unfair trade conditions amongst the trading parties[4].

Transboundary pollution and trade relationship has been investigated by several authors. Copeland and Taylor (1995) and Antweiler et al (1998) examine the effects of trading on the level of global pollution. Markusen (1975), Baumol and Oates (1988), Whalley (1991), Ludema and Wooton (1994) and Copeland (1996) analyse trade policies to control foreign pollution. In a recent work, Benarroch and Thille (1999) study the effects of transboundary pollution under free trade and its welfare effects on the countries.

The works above analyse the case where the pollution is generated through the production of goods in the producer country. In the next chapter, however, we develop a model to analyse a case where pollution is generated through the consumption of imported goods. Pollution can arise during the consumption of commodities. For instance, non-recyclable packaging creates waste as in many plastic bottles. This side of transboundary pollution has not been investigated in the literature. In this paper, we examine a case where consumption of an importable good creates pollution.

Needless to say, a high portion of world trade today takes place in similar products. While some consumers in a country prefer the domestic brand of a good, others may prefer the imported alternative of that good. This leads to an intra-industry trade between countries[5]. According to NAPES (National Asia Pacific Economic and

[4]See Bhagwati (1995) for a discussion on this.

[5]Broadly speaking, intra-industry trade can be distinguished into two categories: horizontal and

Scientific Database) intra-industry trade index, during the period from 1993 to 1995, more than 95 percent of world trade in products such as beverages and tobacco, chemicals, mineral fuels etc. is subject to intra-industry trade. Therefore, one way to see the strategic interaction between trade policies and environmental regulations, and their effects on welfare is to setup a model where similar commodities are traded. In order to do this, we develop a reciprocal dumping type of model in which we analyse the optimal tax policies and some policy reforms in the presence of transboundary pollution[6]. In our model there are two countries and two firms (one in each country). Each firm produces a homogenous good to be consumed in both markets. The policy instruments available to the governments are a consumption tax and a tariff on the imports of that good.

The purpose of the model is to investigate the trade and domestic policies governments use to control the domestic pollution. Using the above specification, we also examine the consequences of two policy reforms on welfare: a bilateral uniform reduction and a revenue neutral reform. Moreover, we compare the two countries to see under which conditions a country imposes higher tax or tariff than its trading partner. The model is detailed in the following section. In section 3, we derive the properties of the optimal policies, while section 4 compares the optimal policy choices in the two countries. Section 5 examines two different policy reforms. Finally, section 6 concludes.

vertical intra-industry trade. The first one means exchange of similar goods that are differentiated by characteristics while the second consists of exchange of similar goods of different quality.

[6]Brander (1981) developed a model to analyse the effects of competition between oligopolistic firms on international trade. He showed that this rivalry leads to a two-way trade in identical products. Brander and Krugman (1983) generalise Brander (1981) to show how dumping arises and how such dumping can be reciprocal (i.e., there may be two-way trade in the same product).

## 2 The Basic Model

We develop a partial equilibrium model of the reciprocal dumping type in which there are two countries, labelled home country ($h$) and foreign country ($f$). Each country has one firm that produces a homogenous good to be consumed in both markets. The markets are segmented so that each firm takes each country as a separate market and makes its decision accordingly. The inverse demand function of the good in the home and foreign countries is given by

$$p^i = \alpha^i - \beta^i D^i, \qquad i = h, f \tag{1}$$

where $p$ is the price, and $D$ is the total demand of the $i$'th country ($i = h, f$) for the good. The domestic firm produces output $x^h$ for domestic consumption and output $x^f$ for foreign consumption. Similarly, $y^f$ is the amount the foreign country produces for its own market and $y^h$ is the production for exports. Hence, the total demand of the countries is given by the following equation.

$$D^i = x^i + y^i, \qquad i = h, f \tag{2}$$

The profits of the firms located in country $h$ and country $f$ are given by, respectively

$$\pi^h = (p^h - c_x - t^h)x^h + (p^f - c_x - t^f - \tau^f)x^f \tag{3}$$

$$\pi^f = (p^f - c_y - t^f)y^f + (p^h - c_y - t^h - \tau^h)y^h \tag{4}$$

where $c_j$ is the marginal cost of the firms in each country ($j = x, y$), $t^i$ is the specific consumption tax, and $\tau^i$ is the specific import tariff ($i = h, f$). The profit maximising choice of $x^h$ is independent of $x^f$ and similarly for $y^f$ and $y^h$.

Under the Cournot-Nash assumptions the optimal outputs of each firm are as follows:

$$x^h = \frac{1}{3\beta^h}\{\alpha^h - 2c_x + c_y - t^h + \tau^h\} \quad (5)$$

$$x^f = \frac{1}{3\beta^f}\{\alpha^f - 2c_x + c_y - t^f - 2\tau^f\} \quad (6)$$

$$y^h = \frac{1}{3\beta^h}\{\alpha^h + c_x - 2c_y - t^h - 2\tau^h\} \quad (7)$$

$$y^f = \frac{1}{3\beta^f}\{\alpha^f + c_x - 2c_y - t^f + \tau^f\} \quad (8)$$

It is clear from equations (5) to (8) that an increase in consumption taxes in either country decreases the output sold in both countries. On the other hand, an increase in tariff set by, say country $h$, increases the amount of output produced by the firm in $h$ for the domestic market while decreasing the amount of imports.

The welfare function of each country has five parts: (i) profit of the domestic firm in each country, (ii) consumer surplus, (iii) consumption tax revenue, (iv) tariff revenue, and (v) disutility from pollution. That is,

$$W^h = \pi^h + CS^h + t^h(x^h + y^h) + \tau^h y^h - \phi^h(x^h + y^h) \quad (9)$$

$$W^f = \pi^f + CS^f + t^f(x^f + y^f) + \tau^f y^f - \phi^f(x^f + y^f) \quad (10)$$

where $CS^i$ and $\phi^i$ $(i = h, f)$, respectively, denote the consumer surplus and the constant marginal disutility of pollution in country $i$.[7]

It is well known that

$$dCS^i = B^i D^i dD^i, \qquad i = h, f \quad (11)$$

Totally differentiating (9) and (10), and using (11) we get:

$$3\beta^h \, dW^h = \{\beta^h(y^h - x^h) - 2t^h - \tau^h + 2\phi^h\}dt^h$$

[7]The assumption of constancy $\phi^i$ is made without any loss of generality. If we considered a more general disutility function $\phi^i$, the ensuing analysis will go through by replacing $\phi^i$ by $\phi^{i'}$.

$$
\begin{aligned}
& & & +\{\beta^h(x^h + 2y^h) - t^h - 2\tau^h + \phi^h\}d\tau^h \\
& & & -2\beta^h x^f dt^f - 4\beta^h x^f d\tau^f & (12) \\
3\beta^f \ dW^f & = & & \{\beta^f(x^f - y^f) - 2t^f - \tau^f + 2\phi^f\}dt^f \\
& & & +\{\beta^f(y^f + 2x^f) - t^f - 2\tau^f + \phi^f\}d\tau^f \\
& & & -2\beta^f y^h dt^h - 4\beta^f y^h d\tau^h & (13)
\end{aligned}
$$

We shall discuss first the effects of each government's tax policy on the welfare of its own nationals. For example, when country $h$ raises the non-discriminatory consumption tax ($t^h$), pollution in that country is reduced. The reduction in pollution benefits country $h$ with the magnitude of this benefit depending on the marginal disutility of pollution in that country. This benefit is given by the last term in the coefficient of $dt^h$ in equation (12). An increase in $t^h$ also reduces the amount of goods imported thus, reducing the tariff revenue for a given tariff rate. Furthermore, the profits of the domestic firm and the consumer's surplus decrease while the tax revenue increases as the consumption tax increases.

When country $h$ increases the tariff rate ($\tau^h$), the amount of pollution caused by the consumption of the imported goods becomes lower. This benefits country $h$ and the magnitude once again depends on the size of the marginal disutility of pollution in country $h$. Contrary to the consumption tax case, an increase in tariff raises the level of domestic profits while decreasing the consumer's surplus. The loss in consumer's surplus, however, is dominated by the increases in profit and the tariff revenue. Note that an increase in the tariff rate increases the domestic output and decreases the amount of goods imported. This will have two opposite effects on the consumption tax revenue. First, a positive effect because of an increase in domestic production, and second, a negative one due to a decrease in imports. The net effect is negative as shown by the second term in the coefficient of $d\tau^h$ in equation (12). This means that the reduction in imports due to the direct effect on imports of a tariff increase dominates the increase in domestic production due to the cross effect (the effect on domestic production) of a tariff increase.

Finally, it is clear from (12) that the external effects of each government's tax policies (both the consumption tax and the tariff) on the other country's welfare are negative. An increase in the consumption tax (or tariff rate) set by country $f$ reduces the amount of goods exported by country $h$ firm, hence reducing its profits. In turn, this has a negative effect on country $h$'s welfare.

# 3 Optimal Policies

In this section, we find the optimal levels of tax policies when the governments take each other's decision as given. The non-cooperative consumption taxes and import tariffs can be found by equating the coefficients of $dt^h$, $d\tau^h$ in equation (12) and $dt^f$, $d\tau^f$ in equation (13) to zero. Then, solving them simultaneously for the optimal taxes and tariffs yields

$$t^h = -\frac{1}{2}\{2\alpha^h + c_y - 3c_x - 4\phi^h\} \tag{14}$$

$$t^f = -\frac{1}{2}\{2\alpha^f + c_x - 3c_y - 4\phi^f\} \tag{15}$$

$$\tau^h = \alpha^h - c_x - \phi^h \tag{16}$$

$$\tau^f = \alpha^f - c_y - \phi^f \tag{17}$$

As can be seen from (14) and (15), the consumption tax in each country is negative if the marginal disutility of pollution is very small. In this case, each government subsidises the local consumption of the good to reduce the monopoly distortion. This will not only benefit the firm producing locally but also the firm abroad (source of imports) as consumption taxes are non-discriminatory. However, from (16) and (17) it is clear that if the marginal disutility of pollution is very small, each country sets a positive tariff on imports, thus discouraging the consumption of the imported good. The optimal consumption tax (in both countries) is positive when the marginal disutility of pollution is high. That is, when the social cost of pollution due to consumption of a good is high the optimal policy is to tax the consumption of that good.

The government is endowed with two policies: consumption tax and import tariff. If the government determines the policies simultaneously and if the society starts to care more about the pollution, the consumption tax increases, while the import tariff decreases. This is because, in this model, consumption tax is designed to target pollution while tariff regulates trade.

# 4 Comparison of the Two Countries

In this section, we compare the equilibrium levels of optimal tax policies of the two countries to see under which conditions a country imposes higher tax or tariff than its trading partner.

i) Consumption Tax: We shall start with the consumption taxes. Subtracting equation (15) from (14) we get

$$t^h - t^f = \alpha^f - \alpha^h + 2(c_x - c_y + \phi^h - \phi^f) \tag{18}$$

Having derived a general expression, we can consider one set of parameters to be different and the rest identical. First, starting with identical consumption preferences ($\alpha^h = \alpha^f$) and costs of production ($c_x = c_y$) but different pollution preferences ($\phi^h \neq \phi^f$), one can see from (18) that the country with higher marginal disutility from pollution imposes higher consumption taxes to regulate environmental standards. Second, when the countries differ only with respect to the costs of production, we find that $t^h > t^f$, if and only if $c_x > c_y$. That is, the country where the less efficient firm is located sets the tax rate higher than the other country with more efficient firm. Finally, when the costs of production and the marginal disutility from pollution are the same, but the consumption preferences are different in the two countries ($\alpha^h \neq \alpha^f$), it is clear from (18) that the country with higher demand (for any given price) imposes lower tax rate than the other country with lower demand.

ii) Import Tariff: Next, we shall consider the comparison of tariffs between the

two countries. Subtracting equation (17) from (16) we get

$$\tau^h - \tau^f = \alpha^h - \alpha^f + c_y - c_x + \phi^f - \phi^h \tag{19}$$

Contrary to the previous case, when consumption preferences ($\alpha^h = \alpha^f$) and costs of production ($c_x = c_y$) in the two countries are the same, but pollution preferences are different ($\phi^h \neq \phi^f$), we find that the country with lower marginal disutility from pollution imposes higher tariff rates. That is, when the countries are identical in all respect but have different preferences for pollution, the country with higher marginal disutility for pollution imposes higher consumption tax and lower tariff rates. The same contradiction continues when it comes to the cases of different costs of production and different consumption preferences. Hence, when the countries differ only with respect to the costs of production, we get $t^h > t^f$ if and only if $c_x < c_y$; and when the countries differ only with respect to the consumption preferences we have $t^h > t^f$ if and only if $\alpha^h > \alpha^f$. Stating the results of this section formally,

**Proposition 1:** *When the countries are identical in all respect but have different*

*a) preferences for pollution, the country with higher marginal disutility for pollution imposes higher consumption tax and lower tariff rates,*

*b) costs of production, the country with less efficient firm imposes higher consumption tax and lower tariff rates,*

*c) consumption preferences, the country with larger demand imposes lower consumption tax and higher tariff rates.*

# 5 Policy Reforms

In this section we analyse the effects on welfare in both countries of two types of policy reforms: bilateral uniform reduction and revenue neutral reform when the initial

levels are set at the non-cooperative level. This can be seen as a multilateral effort to coordinate tax policies.

## 5.1 Infinitesimal Uniform Reduction

When the initial levels are set at the non-cooperative level, the coefficients of $dt^h$, $d\tau^h$ in equation (12) and $dt^f$, $d\tau^f$ in equation (13) are equal to zero. We consider the case where the uniform reduction is made on both policies. Thus, the reform is defined as

$$dt^h = dt^f = d\tau^h = d\tau^f = -\epsilon \tag{20}$$

Substituting (14) and (16) in (12), and (15) and (17) in (13), and using (20) we find the effects of uniform reduction reform on the welfare of the individual countries as follows

$$dW^h\Big|_{t^h=t^{h^N},\ \tau^h=\tau^{h^N}} = 2x^f\epsilon > 0 \tag{21}$$

$$dW^f\Big|_{t^f=t^{f^N},\ \tau^f=\tau^{f^N}} = 2y^h\epsilon > 0 \tag{22}$$

By adding up equations (21) and (22), we get the effect on the global welfare of the infinitesimal uniform reduction reform as

$$dW|_{t^i=t^{i^N},\ \tau^i=\tau^{i^N}} = 2(x^f + y^h)\epsilon > 0 \qquad i = h, f$$

**Proposition 2:** *Starting from Nash, an infinitesimal uniform reduction in both consumption taxes and import tariffs is strictly Pareto improving.*

The welfare of the countries strictly improves as a result of a uniform reduction in both consumption taxes and import tariffs. The intuition is straightforward. If the governments decrease the consumption tax, the price the consumers face will fall. Hence, the consumer surplus will go up in each country. Although the tax revenue

earned from the consumption tax decreases the welfare, the increase in the consumer surplus more than compensates it. Hence, both the welfare in each country and the global welfare increase. On the other hand, the price of the imported good is affected by the tariffs imposed. Hence, a small reduction in the import tariffs will decrease price, which in turn increases consumer surplus. This gain is greater than the decrease in the tariff revenue of the government. Therefore, global welfare strictly improves as a result of a uniform reduction in both consumption taxes and import tariffs, because both reductions induce a decrease in the price. As we mentioned in the cases above, the decrease in the prices increases the consumer surplus in both countries. Clearly, the gain from the increase in the consumer surplus is larger than the loss in the tax revenues of the governments. This result is true for proportionate uniform reduction as well[8].

## 5.2 Revenue Neutral Reform

We shall now consider the revenue neutral reform at the non-cooperative values of the optimal policies[9]. The tax revenue of country $h$ and $f$ are, respectively given by

$$T^h = D^h t^h + y^h \tau^h, \tag{23}$$

$$T^f = D^f t^f + x^f \tau^f \tag{24}$$

The first terms on the right hand side of equations (23) and (24) stand for the consumption tax revenue, while the second terms denote the tariff revenue in each country. For a revenue neutral reform, the change in the tax revenue should be equal to zero. Hence, totally differentiating (23) and (24) for the home and foreign countries respectively, we obtain

[8]Our results suggest that both the individual countries' and global welfare would also be strictly enhanced under a *proportionate* uniform reduction.

[9]A similar analysis can be seen in Delipalla and Keen (1992). In that paper, they make a comparison between ad valorem and specific taxation under imperfect competition.

$$D^h dt^h = -y^h d\tau^h, \tag{25}$$

$$D^f dt^f = -x^f d\tau^f \tag{26}$$

Recall that when the initial levels are set at the non-cooperative level, the coefficients of $dt^h$, $d\tau^h$ in equation (12) and $dt^f$, $d\tau^f$ in equation (13) are equal to zero. Therefore, the effects on the welfare of the home and foreign countries are respectively given by

$$\begin{aligned} dW^h\Big|_{t^h=t^{h^N},\ \tau^h=\tau^{h^N}} &= \frac{2}{3}(x^f + 2y^f)dt^f \\ &= -\frac{2}{3}[\frac{x^f(x^f+2y^f)}{x^f+y^f}]d\tau^f \end{aligned} \tag{27}$$

$$\begin{aligned} dW^f\Big|_{t^f=t^{f^N},\ \tau^f=\tau^{f^N}} &= \frac{2}{3}(y^h + 2x^h)dt^h \\ &= -\frac{2}{3}[\frac{y^h(y^h+2x^h)}{x^h+y^h}]d\tau^h \end{aligned} \tag{28}$$

**Proposition 3:** *Starting from non-cooperative equilibrium, a revenue neutral reform, that is, increasing the consumption tax while decreasing the import tariff is welfare improving.*

An import tariff differs from a consumption tax as the import tariff is imposed on the goods imported while the consumption tax is imposed on both the imported and domestic goods consumed within the country. Thus, an import tariff is discriminatory against the imports. In this case, a decrease in the import tariff in the foreign country will improve welfare in the home country. The tariff imposed by the foreign government applies only to the goods exported by the home country firm. Thus, a reduction in the import tariff in the foreign country will increase the goods exported by the home country to the foreign country. A reduction in the consumption tax will also encourage the home country firm to export more goods to the foreign country as in the tariff reduction case. However, the consumption tax is applied to goods both imported from

the home country and produced by the local firm in the foreign country. Therefore, the effect on welfare of a reduction in the tariff will be higher than the effect on welfare of a reduction in the consumption tax. Because the reform in this section is a tax revenue-neutral type, it is clear from (27) that in order the home country's welfare to be improved the consumption tax in the foreign country must increase while the import tariff decreases. Equation (28) can be used to examine the case for the foreign country.

# 6 Conclusion

Transboundary pollution or cross-border pollution is the movement of pollution across national boundaries. One of the externalities of transboundary pollution is caused by consumption or final use of goods (for example, goods that have non-recyclable packaging). This essentially occurs as a result of trade. Obviously this may influence the environmental quality in other countries. Transboundary pollution and trade relationship has been widely investigated in the recent past. However, the relationship between trade and pollution, precisely when pollution arises during consumption of goods is somewhat neglected. In this work, we introduced a simple model to investigate the responses of the governments to pollution generated by the consumption of both the imported good and the domestic product.

There are two policies available for the governments of the two countries: consumption taxes and import tariffs. Each country has one firm that produces a homogeneous good to be consumed in both markets. The markets are segmented so that each firm takes each country as a separate market and makes its decision accordingly. Pollution occurs during the consumption of goods by both societies. The governments in the two countries may use consumption tax in a non-discriminatory way to reduce pollution from consumption, and they may use tariff to regulate trade between the two countries.

In order to see the under which conditions a country imposes higher tax or tariff

than its trading partner we compared the two countries under several scenarios. Our results suggest that the conditions satisfying higher consumption taxes in a country also satisfy lower tariffs in that country. In particular, we found that a country will impose higher consumption tax and lower tariff rates if it has either of the following: higher marginal disutility from pollution, higher unit costs, or smaller demand than the other country. We also show that an increase in the marginal disutility of pollution increases the consumption tax, while decreasing the import tariff.

Finally, we examine the consequences of two policy reforms on welfare: a bilateral uniform reduction and a revenue neutral reform. It is found that starting from non-cooperative solutions, an infinitesimal uniform reduction is unambiguously Pareto improving for each country and for the global welfare. This is because the gain from an increase in consumer surplus due to reform is larger than the loss in the tax revenues of the governments. In the revenue neutral reform case, welfare of the countries will be Pareto improving if the consumption tax is increased while the import tariff is reduced.

# References


Andersson, T., C. Folke and S. Nyström, 1995, *Trading With the Environment* London, Earthscan Publications Ltd.

Antweiler, W., B.R. Copeland and M.S. Taylor, 1998, Is Free Trade Good for the Environment?

Arnason, R., 1990, Minimum Information Management in Fisheries, *Canadian Journal of Economics*, vol. 23, pp. 630-53.

Barnett, H. J. and C. Morse, 1963, *Scarcity and Growth: The Economics of Natural Resource Availability*, Johns Hopkins University Press.

Baumol, W.J., and W.E. Oates, 1988, *The Theory of Environmental Policy* Cambridge, Cambridge University Press.

Benarroch, M. and H. Thille, 1999, Transboundary Pollution and the Gains From Trade, University of British Colombia Discussion Papers.

Berck, P., 1981, Optimal Management of Renewable Resources with Growing Demand and Stock Externalities, *Journal of Environmental Economics and Management*, vol. 8, pp. 105-17.

Bhagwati, J., 1995, *Free trade, 'fairness' and the new protectionism : reflections on an agenda for the World Trade Organisation* Wincott memorial lecture, 24th Occasional paper, Institute of Economic Affairs, 96, London : Institute of Economic Affairs for the Wincott Foundation.

Brander, J. 1981, Intra-industry Trade in Identical Commodities *Journal of International Economics*, vol. 11, pp. 1-14.

Brander, J., and Krugman P., 1983, A Reciprocal Dumping Model of International Trade *Journal of International Economics*, vol. 15, pp. 313-321.

Copeland, B.R., 1996, Pollution content tariffs, environmental rent shifting, and the control of cross-border pollution, *Journal of International Economics* 40, pp. 459-

476.

Copeland, B.R., and M.S. Taylor, 1995, Trade and transboundary pollution, *American Economic Review* 85, pp. 716-737.

d'Arge, R.C., 1975, On the Economics of Transnational Environmental Externalities, in Edwin S. Mills, ed., *Economic Analysis of Environmental Problems*, National Bureau for Economic Research, Colombia University Press, pp. 397-416.

Delipalla, S., and M. Keen, 1992, The comparison between ad valorem and specific taxation under imperfect competition, *Journal of Public Economics*, pp. 351-367.

Farzin Y. H., 1992, The Time Path of Scarcity Rent in the Theory of Exhaustible Resources, *Economic Journal*, vol. 102, pp. 813-30.

Halvorsen, R. and T. R. Smith, 1991, A Test of the Theory of Exhaustible Resources, *Quarterly Journal of Economics*, pp. 123-40.

Lahiri, S., and A. Muthoo, 1996, An Approach to Forest Policy Analysis, *mimeo*, University of Essex.

Ludema, R.D., and I. Wooton, 1994, Cross Border Externalities and Trade Liberalisation: The Strategic Control of Pollution, *Canadian Journal of Economics*, vol. 27(4), pp. 950-66.

Markusen, J.R., 1975, International Externalities and Optimal Tax Structures, *Journal of International Economics*, vol. 5, pp. 15-29.

Pindyck, R. S., 1984, Uncertainty in the Theory of Renewable Resource Markets, *Review of Economic Studies*, vol. 51, pp. 289-303.

Pindyck, R. S., 1980, Uncertainty and Exhaustible Resource Markets, *Journal of Political Economics*, vol. 88, pp. 1203-25.

Whalley J., 1991, The Interface between Environmental and Trade Policies, *The Economic Journal*, vol. 101, pp. 180-89.