INTERNATIONAL TRADE AND ITS CONSEQUENCES ON THE ENVIRONMENT: A NOTE

*Giuseppe Di Vita**

1. Introduction

The effects of international trade on the environment are considered not yet completely clear in economic literature. This problem is of such importance that it is the subject of many theoretical papers and technical reports [see, at least, Bagwell and Staiger, 2001, Esty, 2001, WTO, 1999][1]. Copeland and Taylor, in their seminal paper [1994], found that international trade could be harmful to the environment. Recently, however, Antweiler *et al.* [2001] and Eiras and Schaefer [2001] have shown that free trade improves environment quality. We wish therefore to take a closer look at Copeland and Taylor to understand how they obtain their conclusions. In their 1994 paper they supply a new theoretical framework for considering the effects of free trade on the environment; they also break down the changes in the pollution level into scale, technique, and composition effects. Their main results can be summarized as follows: i) in a free trade regime, economic growth has effects on pollution different from those in autarchy; ii) international trade can lead to an increase in world pollution; iii) the migration of polluting industries from North to South, induced by asymmetric growth, has important and interesting effects on pollution through the composition effect; consequently economic growth in the North and in the South has different effects on the environment.

The model is founded, among other things, on four basic assumptions: firstly, environmental quality is considered a "normal good"; secondly, pollution abatement technology allows only a reduction of the pollution discharged into the environment; thirdly, consumer preferences are assumed homothetic;

*. Giuseppe Di Vita, Faculty of Law, University of Catania, via Gallo n. 24, 95124 Catania. E-mail: gdivita@lex.unict.it; telefono: +39-095-230111 (ext. 450); fax: 39-095-321654.

1. For a detailed survey about this issue see Copeland and Taylor (2004).

finally, pollution in itself is considered both as an input and as a by-product of total output production.

Copeland and Taylor [1994, p. 758] mention the pioneering paper of Grossman and Krueger [1991], in which they demonstrate that the pollution level first rises and then falls with a rise in per capita income, but in spite of that, they assume that environmental quality is "always" a normal good.

In this paper, we confine ourselves to considering the effects of international trade on the environment, under Copeland and Taylor's [1994] conditions and analytical framework, to show that in the hypothesis of exogenous pollution taxes the results could be different. It is worth seeing this because their article is widely mentioned in economic literature [see, for example, Antweiler *et al.*, 2001, Beghin *et al.*, 2001, Benarroch and Thille, 2001, Beukering *et al.*, 2000, Cabo *et al.*, 2001, Copeland and Taylor, 1995, Dean, 2001, Eiras and Schaefer, 2001, Eliste and Fredriksson, 2002, Fredriksson, 1999, McAusland, 2003, Schleich, 1999, Stokey, 1998, and Xu, 2000].

Recent econometric analysis shows that trade pushes economic growth and has a direct effect on the environment, reducing pollution (Eiras and Schaefer, 2001). Some other studies reach more prudent conclusions concerning the impact of international commerce on the environment (Frankel and Rose, 2003), but there is no empirical evidence that trade is an obstacle on the road of sustainable development.

The structure of the paper is as follows. In section 2, we summarize Copeland and Taylor's [1994] main assumptions, reporting the equations indispensable to the rest of the paper. Section three is devoted to highlighting the relationship between income and pollution emissions, under the hypothesis of a marginal disutility of pollution greater than or equal to one.

Finally, we discuss our results, suggesting ways of considering further the effects of international trade on worldwide environment.

2. Main Features of Copeland and Taylor's Model

Here we refer to the theoretical framework of Copeland and Taylor [1994], and to simplify the reading of this paper, we report the basic assumptions of their model. Three kinds of agents are considered: firms, consumers and a benevolent social planner that has jurisdiction just inside its own region.

Two countries are considered, the highly developed North and the less developed South. Following Copeland and Taylor, the asterisk (*) denotes the Southern variables. There is a continuum of private consumption goods, indexed by $z \in [0, 1]$, where z is an index of diminishing comparative home country advantage in the production of this good (as in the model of Dornbusch *et al.*, 1977). This is necessary to capture the effects of differing standards of environment protection on trade patterns (in other words a many-goods general equilibrium model is adopted, based on Dornbusch *et al.*, 1977). It is explicitly considered that international trade is always income increasing [Copeland and Taylor, 1994, p. 770].

One primary input is used to produce tradeable goods, effective labor l. It is assumed that South and North have the same access to pollution abatement technologies and an identical number of workers L. The workers are distinguished in the two countries for their effectiveness $A(h)L$, in particular $A(h)L > A(h^*)L$.

The production function is

$$y(d,l;z) = \begin{cases} l^{1-\alpha(z)} d^{\alpha(z)}, & \text{if } d \le \lambda l, \\ 0, & \text{if } d \le \lambda l, \end{cases} \qquad [1]$$

where y = output of good, and d = pollution discharge. $\lambda > 0$ is the pollution discharge and effective labor ratio, and $\alpha(z), \in [\underline{\alpha}, \bar{\alpha}]$ with $0 < \underline{\alpha} < \bar{\alpha} < 1$ is a parameter that varies across goods; a commodity z is associated with each point of the above interval, and for each commodity there are unit labor requirements in the two countries, $a(z)$ and $a^*(z)$. The production function above possesses the characteristic for which, along an isoquant, the firms may choose the optimal combination of labor and pollution to maximize their profit. Without any environmental policy, entrepreneurs have no incentive to implement cleaner production processes[2].

Copeland and Taylor [1994] assume that the government wants to keep the pollution discharge at its optimal level, levying a tax $\hat{e}$ on this input, while w_e is the return to a unit of effective labor.

The optimal combination of two inputs that allows cost minimization is

$$\frac{w_e}{\tau} = \frac{1-\alpha(z)}{\alpha(z)} \frac{d}{l}. \qquad [2]$$

The utility function used in the Copeland and Taylor model is

[3]

$$U = \int_0^1 b(z) \ln[x(z)] dz - \frac{\beta(L,\rho) D^{\gamma}}{\gamma}, \qquad [3]$$

Where $x(z)$ is the consumption of good z, $b(z)$ is the continuum counterpart to the many-commodity budget share, such that $\int_0^1 b(z) dz = 1$. β is an index of the pollution emission effects on the country considered; it depends on L and the community population density ρ, but in the most part the Copeland and Taylor model is considered constant. D is the total amount of pollution generated by the same country in which the agents of the economy live[3], and γ is a

2. For more details regarding the derivation of the production function, see Copeland and Taylor [1994] Appendix A.

3. Transboundary pollution is not considered here, but it is studied by Copeland and Taylor in another paper [1995], using a model similar to that of their previous article [Copeland and Taylor, 1994].

parameter of the utility function. The assumption that $\lambda \geq 1$ ensures that the marginal willingness to pay for pollution reduction is a non-decreasing function of pollution levels. In other words, a high level of emissions always implies a growing or, at least, a constant willingness to pay for a pollution reduction. The effect of pollution on utility is considered in the second addend of (3). In particular we can see that $\partial U/\partial D = -\beta(L,\rho)\, D^{\gamma-1}$. We also note that the greater the population and its density, the greater will be the marginal disutility of pollution.

To keep the analysis simple, Copeland and Taylor [1994] assume that the tastes of consumers are homothetic.

In deriving the optimal level of pollution taxes, we refer to the Copeland and Taylor assumptions, for which the representative consumers sell their labor services receiving a wage and an equal share of pollution taxes (I/L, where I is the North income) collected by their government from dirty industries. Calculating the indirect utility function from (3) and maximizing with respect to τ, we get

$$\tau = \beta D^{\gamma-1} I, \qquad [4]$$

(note that the equation above is the same as (7) in Copeland and Taylor's model); we have confined ourselves to the case of exogenous taxes (Copeland and Taylor, 1994, p. 763). (4) simply says that the Pigouvian tax is equal to the marginal damage provoked by pollution emissions in autarchy equilibrium. In other words, we assume that North and South established their pollution tax level before opening to trade. We follow Copeland and Taylor in assuming that $\tau > \tau^*$. The intuition behind this condition is that whenever the South has lower income and emissions levels than the North, this will imply that its marginal disutility of pollution is lesser than in the other area.

The main channels that create comparative advantages between North and South are the different endowments in per capita human capital, such that $h > h^*$, and the different environmental taxations, for which we can think that the North will specialize in intensive human capital productions, that are intrinsically environmental friendly, while the South will produce more polluting goods. Copeland and Taylor consider that these two countries have large disparities in income.

3. The Income-Pollution Pattern in Copeland and Taylor's Model.

To highlight the link between income and pollution emissions, under the hypothesis of $\gamma \geq 1$, we can use [4], to derive D with respect to the income, obtaining:

$$\frac{\partial D}{\partial I} = \frac{\left(\frac{\tau}{\beta I}\right)^{\frac{1}{\gamma-1}}}{(\gamma-1)I}. \qquad [5]$$

From the above equation it is evident that:

$$\frac{\partial D}{\partial I} \begin{cases} -\infty \text{ if } \gamma = 1 \\ > 0 \text{ if } \gamma = 1 \end{cases}.$$

Using (5) we can also calculate the second partial derivative of pollution emissions with respect to the income level, to find:

$$\frac{\partial^2 D}{\partial I^2} = \left(\frac{\tau}{\beta I}\right)^{\frac{1}{\gamma-1}} \frac{\gamma}{(\gamma-1)^2 I^2}.$$

It is immediately possible to conclude that:

$$\frac{\partial^2 D}{\partial I^2} \begin{cases} +\infty \text{ if } \gamma = 1 \\ > 0 \text{ if } \gamma > 1 \end{cases},$$

such that the income-pollution pattern is, for $\gamma > 1$, always decreasing and strictly convex in both countries considered. That relationship does not exist for $\gamma = 1$. This means that in cases where $\gamma > 1$, pollution emissions decrease more than proportionally to a rise in income[4].

Multiplying both sides of (5) by I/D, we obtain the income pollution emissions elasticity

$$\varepsilon_{D,I} = \frac{\partial D}{\partial I}\frac{I}{D} = -\frac{\left(\frac{\gamma}{\beta I}\right)^{\frac{1}{\gamma-1}}}{(\gamma-1)D}. \qquad [6]$$

This imply that:

$$\varepsilon_{D,I} = \begin{cases} -\infty \text{ if } \gamma = 1 \\ < 0 \text{ if } \gamma > 1 \end{cases}.$$

We may report the income-pollution pattern in the figure below

4. From [4], we can say, in cases where $\gamma > 1$, that $D(\tau)$ is increasingly convex and $I(\tau)$ is growing linear.

Figure 1 – Income-Pollution Pattern

From the results above we can derive the following

PROPOSITION 1: *For $\gamma \geq 1$, if international trade is income increasing both in the North and in the South, it will in any case increase environmental quality in both the areas considered.*

The intuition behind this result is fairly simple. Under the assumptions of Copeland and Taylor [1994], the pollution-income pattern is described by an decreasing convex function in both countries under study (see figure 1), such that if international trade is always income increasing in both North and South, the positive effects on the environment always outweigh the negative ones[5]. In other words, assuming that $\gamma \geq 1$ we consider only developed countries, in that case it does not make sense to investigate further the effects of international trade on the environment in this kind of nation, because the increase in income is always environmental quality improving. This result is reinforced by the assumption of Copeland and Taylor for which the North and South have large income disparities [Copeland and Taylor, 1994, p. 757]; in this case it is probable that one of two countries will fall into the category of income-pollution pattern in which $\varepsilon_{D,I}$ is greater than minus one. Recently, the World Trade Organization cast light on the so-called "scale effect" on the environment, suggesting that a high per capita income level makes it possible to implant more clean production techniques, that are not economically feasible at a lower level of income [WTO, 1999, p. 50].

From (6) it is evident that $\varepsilon_{D,I} > 0$ if and only if $\gamma < 1$. Note that the latter hypothesis regarding is not considered in Copeland and Taylor's model, but in spite of that they assume that the income pollution emissions elasticity is positive and equal to one. Using the information deriving from the income-pollution pattern functional form, we can say that, in cases where $\gamma > 1$, the pollution emissions are an inferior good (i.e. $\varepsilon_{D,I} < 0$). This implies that consumer preferences are never homothetic.

Therefore we can write the following

PROPOSITION 2: *For $\forall D > 0$ and $\gamma > 1$, the income pollution emissions elasticity will always be negative, such that D is an inferior good.*

To give an economic interpretation of this result, we need to remember that countries with high levels of income can bear the costs of expensive pollution abatement technologies. Indeed, the condition for which $\gamma \geq 1$ implies that the consumers of both countries involved in international trade always consider that the marginal disutility of pollution emissions is greater than the marginal utility of consumption.

To consider the effects of a change in tax level on pollution emissions, we put in evidence D in [4], and deriving with regard to τ, holding constant I, we get

$$\frac{\partial D}{\partial \tau} = \frac{\left(\frac{\tau}{\beta I}\right)^{\frac{1}{\gamma-1}}}{(\gamma-1)\tau} \qquad [7]$$

Thus we can write

$$\frac{\partial D}{\partial \tau} = \begin{cases} > 0 \text{ if } \gamma > 1 \\ +\infty \text{ if } \gamma = 1 \end{cases}$$

We can also show that the elasticity of Pigouvian taxes of pollution differs by -1, as stated in equation [20] by Copeland and Taylor [1994, p. 769][6].

5. It is worth to highlight that if $\gamma < 1$, the relationship between income and pollution is increasing, describing the typical situation of a developing country in which emission and income rise together (i.e. we are in the first part of Environmental Kuznets Curve). Under this condition all the results of the model will be opposite at those we have obtained.

6. Multiplying *(7)* by I/τ, we can calculate the elasticities of polluting emissions with respect to Pigouvian taxes, to get

$$\varepsilon_{D,\tau} = \frac{\partial D}{\partial \tau}\frac{\tau}{D} = \frac{\left(\frac{\tau}{\beta I}\right)^{\frac{1}{\gamma-1}}}{(\gamma-1)D}, \text{ for which } \gamma \begin{cases} > 1 \Rightarrow \varepsilon_{D,\tau} > 0. \\ = 1 \Rightarrow \varepsilon_{D,\tau} + \infty. \end{cases}$$

It is worth highlighting that the elasticity that we have found is not equal to one, and also that it has different signs, for $\gamma > 1$, from that obtained by Copeland and Taylor.

These results reinforce our findings for which the consumer preferences are not homothetic. In this way, under the assumption that $\gamma \geq 1$, we can see that the technique effect is negative. This result is perfectly consistent with the income-pollution pattern, because a reduction of I, caused by a positive change in taxation, decreases the economic capacity to install strong pollution abatement devices. The outcomes that we derived here, regarding scale and technique effects, are perfectly opposite to those obtained by Copeland and Taylor [1994]. Under the hypothesis of exogenous pollution taxes, and for $\gamma \geq 1$, it does not make sense to consider the so-called 'composition effect' because the model assumption concerning consumer preferences ensures that the scale and technique effects always outweigh the composition effect. This is evident from Figure 1, in which pollution declines with a rise in income level.

4. Comment on Results

In this short paper we have shown that under the conditions of Copeland and Taylor's model [1994], we consider the international trade between two countries in which an increase in income always reduces pollution emissions, such that the commerce between those kinds of nation will always improve environmental quality in both North and South. Moreover, a rise in Pigouvian taxes increases the pollution in the economic system, for which the technique effect is environmental reducing for $\gamma \geq 1$. In this way the difference in human capital and taxation level between North and South does not explain the effects of international trade on worldwide environment, but only the reasons for commerce between nations.

This happens because we assume that the marginal willingness to pay for a pollution emission reduction is a non decreasing function of pollution levels (i.e. $\gamma \geq 1$). Thus if we really wish to consider the effects on the environment of international trade between two countries, a rich Northern one and a less developed Southern one, we should consider that in the latter the marginal willingness to pay for a reduction of pollution emission is positive, but lower than one (i.e. $0 < \gamma < 1$). The explanation of this assumption is straightforward: before considering the problem of environmental quality, poor countries normally take into account ways to satisfy their basic needs; they are thus more prepared to accept a reduction in their environmental quality (that is a not tradeable good) in order to achieve higher monetary income.

In our analysis it is evident that, if $\gamma \geq 1$, an increase in income always improves environmental quality, because the kind of countries considered in the model can pay to implement stronger pollution abatement technologies, and the higher quantities of output produced reduce the incidence on the average cost of adopting these devices. On the other hand, an increase in Pigouvian taxes reduces monetary income and causes a fall in the environmental quality level in rich countries.

To extend the Copeland and Taylor model to the case in which North and South differ in their marginal willingness to pay for pollution emissions reduction, we should take into account that the income pollution emissions elasticity is not the same in both countries considered. We have demonstrated that $\varepsilon_{D,I}$ is negative, but more in general we have shown that the hypothesis of homothetic consumer preferences is not always verified even in Copeland and Taylor's model. To give up the assumption of homothetic preferences implies a considerable complication of the theoretical framework, but it is necessary to obtain more realistic theoretical results and suggestions for political economy. In our opinion, to study the effects of international trade between North and South we must assume that in the poor country $\gamma < 1$. This implies that income and pollution increase together in the South (i.e. we are in the increasing branch of the environmental Kuznets curve), while the North emission and income move in opposite directions. This seems a more realistic point of departure for real world modeling.

More research is necessary to set up the problem of international trade effects on the environment in a dynamic model, in which the assumptions on the marginal willingness to pay for pollution reduction reflect the different income-pollution pattern in North and South, and to distinguish the scale, technique and composition effects of a pollution change in both countries.

The main result of our analysis is that free trade increases environmental quality in all the countries involved, essentially as a consequence of scale and technique effects, but the South may experience a period in which income and emissions grow together. International capital movements and foreign direct investment, jointly with more clean technologies, may encourage the developing countries to move towards a more sustainable path. The obvious implication of economic policy is that the poor nations should promote direct investment with the implementation of more friendly environmental production processes by foreign investors attracted by the lower cost of labor in the South of the world.

Acknowledgments

Part of this paper was written while the author was visiting the Interdisciplinary Institute for Environmental Economics, University of Heidelberg. Thanks to two anonymous referees, Roberto Cellini, Brian Copeland and Till Requate for their useful suggestions and comments to a former version of this paper. All errors are the author's alone. This research has been financed in part by the University of Catania.

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Abstracts and summaries

Transitory provisions on public gas distribution in the light of the Marzano law, by Arianna Vedaschi

The article begins by describing community law on public gas distribution service, then it examines legislative decree 164/2000 (also called Letta Decree), which implements directive no. 98/30/CE. This directive reforms the gas sector and in particular it reforms the way gas is distributed. Art. 14 of the Letta Decree states that the distribution of natural gas shall be a public service, contractors shall be selected through a public tender and contracts shall be stipulated for a maximum of 12 years.

Thus it is evident that the new model is radically different from the previous one. Before, the service was provided by the local authorities (either directly or through a long-term lease); now the new model aims at liberalizing the market by outsourcing gas distribution. Outsourcing is carried out through a public tender and for short periods of time.

In order to allow a gradual transition from the old model to the new one, the Letta Decree provides for a transitory period articulated in various phases. This has the aim of guaranteeing a balance between the interest of local authorities, on one hand and the firms that distributed gas before the reform came into effect, on the other.

The first part of the article focuses on interpretative problems that arose after law no. 239/2004 (so called Marzano law) was passed. In the second half it compares the different judicial interpretations concerning: a) duration of the transitory period; b) possibility of increasing duration as provided for by art. 15, par. 7 of legislative decree 164/2000; c) efficacy of the abrogation of art. 15, par. 8 of legislative decree 164/2000 and finally d) whether advanced redemption of the gas distribution service is still possible.

With regard to the transitory period, the article compares judgment no. 111/2005 by the Administrative Tribunal of Lombardia, with judgment no. 6187/2005 delivered by the Sixth Section of the State Council. It then argues that the prohibition of concentration has an *ex nunc* efficacy. Finally, it compares the opposing opinions of the Administrative Tribunal of Lombardia and that of the State Council (Sixth Section) on redemption. It should be underlined that the issue of redemption was then solved by art.