Trade Liberalization, Transboundary Pollution, and the Global Pollution Agreement

Abstract

By introducing the global pollution agreement, this paper develops a two-country, two-good, general-equilibrium model with a dual approach to examine the impacts of trade liberalization in commodities and in pollution permits on pollution levels and welfare. The paper's focus is on how the price elasticity of Northern import demand affects pollution levels through the real income effect. It shows that trade liberalization in commodities may reduce worldwide pollution levels, worsen Southern welfare, and improve Northern welfare under a set of stringent conditions. Moreover, allowing pollution permits to be tradable internationally may increase worldwide pollution levels. This paper also shows that the South will benefit from the system of carbon trading, whereas its impact on Northern welfare is ambiguous.

Key Words: North-South trade, trade liberalization, transboundary pollution, Kyoto Protocol

There has been a growing interest on the linkage between international trade and the environment in recent years. Two categories of articles can be classified based on the nature of pollution. One treats pollution as a pure public bad: all countries are equally exposed to a given unit of pollution, regardless of its source; see Copeland and Taylor (1995), Copeland (1996), Ludema and Wooton (1994), Markusen (1975), Perroni and Wigle (1994). The other treats it as a local public bad: pollution damage is confined to the emitting country; see Chichilnisky (1994), Copeland and Taylor (1994), Copeland (1994).

In particular, Copeland and Taylor (1995) develop a static two-country general-equilibrium model with a

continuum of goods differing in their pollution intensity of production. Assuming that pollution is a pure public bad, they obtain the following results. Free trade raises worldwide pollution levels if income differs substantially across countries. Northern countries lose but Southern countries gain from trade, if trade equalizes factor prices. International trade in pollution permits can lower worldwide pollution levels even when the government's supply of permits is unrestricted. In their paper, Copeland and Taylor assume that both Northern and Southern governments choose their own pollution target efficiently, however, this assumption may not be fulfilled if we consider the global pollution agreement signed just recently.

During December 1997, a major world conference took place in Kyoto, Japan, paving the way forward for environmental stability for years to come. In the end, the conference concluded a global pollution agreement, the Kyoto Protocol to the United Nations Framework Convention on Climate Change, hereinafter referred to as the Kyoto Protocol. As quoted in the Kyoto Protocol, 38 industrialized countries were required to reduce their greenhouse emissions by an average of 5 percent from 1990 levels by between 2008 and 2012. However, many developing countries are allowed to set their own voluntary reduction targets. Moreover, some countries suggest that countries who do not meet their own emissions targets can strike deals with nations that do better than required and buy their excess quota: a process now known as "carbon trading." Thus, it should be reasonable to assume that the pollution permits supplied in the North are fixed at a given level, while those in the South are determined by an efficient condition.

As a result of the Uruguay Round of multilateral trade negotiations, participating nations agreed to open markets to promote trade. It is noteworthy that it is quotas rather than tariffs which constitute a major constraint on imports by developing countries. Moreover, trade negotiations between the North and South in recent years have shifted away from focusing on restricting Southern firms' access to Northern markets as a means of expanding Northern firms' access to Southern markets. This kind of trade policy was dubbed voluntary import expansion (VIE) by Bhagwati (1987). A VIE agreement sets a target level or target share for import sales in a domestic market. Hence, we use a relaxation in Southern import quotas to represent trade liberalization in commodities.

Introducing the global pollution agreement, this paper's purpose is to examine the impacts of trade liberalization in commodities and in pollution permits on pollution levels and welfare by using a two-country, two-good, general-equilibrium model with a dual approach. This model differs from that of Copeland and Taylor (1995) in two respects. Firstly, by introducing the global pollution agreement, Northern pollution levels are regulated at five percent below the levels in the year 1990 for each Northern country. Thus, the changes in worldwide pollution levels depend solely on the changes in Southern pollution levels. Secondly, by using a general-equilibrium model with a dual approach, we can examine the role of the traditional price elasticity of import demand, which cannot be derived by Copeland and Taylor's model, on the changes of the pollution levels and welfare.

To demonstrate the importance of

the price elasticity of Northern import demand, we derive that the real income effect exists in the impacts of trade liberalization in commodities and in pollution permits on Southern and worldwide pollution levels. Since pollution quality is a normal good, Southern and worldwide pollution levels fall if the real income goes higher. We show that the smaller the elasticity is, the larger the impact of trade liberalization on the terms of trade is. The elasticity can affect Southern and Northern welfare (i.e., real income) via the terms-of-trade effect. Therefore, the elasticity can in turn change Southern and worldwide pollution levels through changing real income. Accordingly, the paper's focus is thus on how the price elasticity of import demand affects the pollution levels and welfare.

We consider a standard two-country, two-good, general-equilibrium trade model with a dual approach, and modify it to allow for pollution. There are two countries: the highly-developed North and the less-developed South. Northern variables are indicated by an asterisk (*). Each country consists of two industries: the dirtier good, X_1, and the cleaner good, X_2. South exports the dirtier product, and North exports the cleaner product. Good X_1 is chosen as a numeraire. Pollution is modeled as a by-product of goods production. It is assumed that pollution is a pure public bad. Pollution adversely affects the consumers' utility no matter where they live, but it does not generate external effects to production functions.

Suppose that the utility function takes the form of $U(C_1, C_2, Z^W)$, which is a function of good X_i's consumption, C_i, and worldwide pollution levels Z^W. This means that pollution is a pure public bad.

Equivalently, the consumer's preferences can be represented with an expenditure function $E(P, Z^W, u)$, which is derived by $E(P, Z^W, u) = \min. \{C_1 + PC_2: U(C_1, C_2, Z^W) \geq u\}$. Function E is the minimum cost of attaining utility level u, given the price ratio P and worldwide pollution levels. Moreover, E is concave in P, non-decreasing in P, and increasing in u.

As is the convention in international trade literature, the private sector maximizes the country's national income. This yields a *GNP* function $G(P, s)$, which is obtained from $G(P, s, v) = \max. \{X_1 + PX_2 - sZ: (X_1, X_2, Z) \in T(v)\}$, where X_i is the output of good X_i, s denotes the pollution-permit price, Z represents Southern pollution levels, T is the production transformation function, and v denotes the endowments of inputs vector. Function $G(P, s)$ is the maximum value of national income, given production technology T and factor endowments v. This function, G, satisfies the standard properties of a restricted profit function, and is convex in (p, s).

In the beginning, we assume that the South imposes a quota restriction to her commodity imports, whereas there is no international trade in pollution permits. The South's consumer expenditure equals the net value of output plus pollution tax and quota rents, which are collected by the Southern government through the auctioning off of import licenses and through the consumer rebate. The definition of the North's consumer expenditure is the same as that for the South except that the commodity quota rents are replaced by the pollution-permit quota rents. Thus, Southern and Northern budget constraints are, respectively, expressed as:

$$E(P, Z^w, u) = G(P, s) + sZ + (P - P^*)Q, \quad (1)$$

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$$E^*(P^*, Z^w, u^*)$$
$$= G^*(P^*, s^*) + s^* Z^* + (s^* - s)Q_z, \qquad (2)$$

where Q denotes the commodity import quotas imposed by the Southern government; Q_z represents the import quotas of pollution permits set by the Northern government. Initially, Q_z equals zero due to the assumption that there is no international trade in pollution permits in the beginning. Northern pollution levels Z^* are assumed to be fixed in compliance with the restriction set by the Kyoto Protocol. The left-hand side (LHS) of (1) and (2) represents the country's total expenditure, while the right-hand side (RHS) denotes the country's aggregate income.

Worldwide pollution levels can be obtained from aggregating the pollution levels in the North and South. This can be expressed as

$$Z^w = Z + Z^*. \qquad (3)$$

The Southern government's problem is to choose an optimal amount of pollution levels to maximize her welfare, taking as given consumer and producer behavior. We assume that the Southern government treats the terms of trade as given when choosing her environmental policy. Thus, maximizing the Southern utility level with respect to pollution permits, and treating the terms of trade as given, yields:

$$s = E_z(P, Z^w, u), \qquad (4)$$

where $E_z \equiv \partial E / \partial Z^w$ represents the direct marginal pollution damage to Southern consumers caused by pollution. The optimal condition requires that the government set the pollution tax equal to the direct marginal pollution damage to consumers caused by pollution.

By the envelope theorem, the equilibrium condition for Northern and Southern pollution permits requires that the domestic demand for pollution permits be equal to supply:

$$Z - Q_z = -G_s(P, s), \qquad (5)$$
$$Z^* + Q_z = -G_s^*(P^*, s^*), \qquad (6)$$

where $-G_s \equiv -\partial G / \partial s$ denotes the demand for Southern pollution permits. The LHS of (5) and (6) denote the net supply of pollution permits, which equal the pollution amount set by the government minus (plus) the exported (imported) pollution permits. The RHS represent the demand for pollution permits.

Since we assume that there is a quota restriction to Southern imports, the equilibrium condition for good X_2 requires that domestic demand be equal to its supply. This can be described as:

$$E_p(P, Z^w, u) = G_p(P, s) + Q, \qquad (7)$$
$$E_p^*(P^*, Z^w, u^*) = G_p^*(P^*, s^*) - Q, \qquad (8)$$

where $E_p \equiv \partial E / \partial P$ denotes the consumer's compensated demand function. The LHS of (7) and (8) is the demand for good X_2 in each country. The RHS of (7) and (8) represents the net supply of good X_2, which equals its domestic output G_P plus (minus) imports (exports). Thus, (7) and (8) constitute the market-clearing conditions for good X_2. By Walras's law, the market of good X_1 is also cleared. Note that the budget constraints along with the market-clearing conditions imply balanced trade for both countries.

With the aid of the above model, we obtain the following results. By introducing the global pollution agreement, this paper has examined the impacts on pollution levels and welfare from trade liberalization in commodities and in pollution permits. The focus of this paper has been the real income effect in determining Southern and global pollution levels. We show that the price elasticity of Northern import demand is the crucial factor in the real income effect. Moreover, this elasticity can affect Northern and Southern welfare via

changing the terms-of-trade effect, because this elasticity is the main factor to the terms-of-trade effect.

By assuming that the Southern exportable good is pollution intensive, we obtain several striking results. First of all, unlike the argument asserted by Copeland and Taylor (1995) as well as environmentalists - that, is trade liberalization in commodities will raise worldwide pollution levels - we show that trade liberalization does not necessarily increase worldwide pollution levels. The levels may decrease if the price elasticity of Northern import demand and the price distortion caused by the import quota are sufficiently large. Secondly, Southern welfare worsens if this elasticity is sufficiently small, whereas Northern welfare improves if the elasticity and the price distortion caused by the import quota are sufficiently large. Thirdly, allowing international trade in pollution permits does not necessarily lower Southern and worldwide pollution levels. These levels rise if the price elasticity of Northern import demand is sufficiently large. Furthermore, since allowing pollution permits to be tradable internationally benefits Southern welfare, we may conclude that the South will benefit from the system of carbon trading. However, its impact on Northern welfare is ambiguous.

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