

The Non-Neutrality of WTO Border Tax Adjustments for Environmental Excise Taxes under Imperfect Competition*

Steve McCorrison (University of Exeter, UK)

Ian M. Sheldon (The Ohio State University, USA)

Abstract:

Border tax adjustments for environmental taxes should leave imports of final goods unchanged. If intermediate and final goods markets are imperfectly competitive though, non-neutrality can result. Under Cournot behavior, an import tax equal to the environmental tax is too high, and under Bertrand, an import subsidy is the appropriate policy.

Keywords: Environmental/border taxes; imperfect competition

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Address of Corresponding Author:

Ian M. Sheldon
Department of Agricultural, Environmental and Development Economics
The Ohio State University
2120 Fyffe Road, Columbus, Ohio-43210.

Voice-mail: 614-292-2194

Fax: 614-292-0078

e-mail: sheldon.1@osu.edu

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1. Introduction

Tax instruments with the aim of improving the environment are used widely in many countries. In the US, excise taxes are levied on products that adversely affect the environment, e.g., chlorofluorocarbons, while others have been and are used as a source of revenue to deal with (potential) environmental hazards. In several European countries (Denmark, the Netherlands, Norway and Sweden) carbon taxes currently apply while the European Commission has considered the use of carbon taxes throughout all members of the European Union (EU). The US government has also considered the introduction of carbon taxes. The use of excise taxes for environmental purposes, however, is likely to impact on trade flows and the competitiveness of firms to which the environmental tax applies. Clearly, manufacturers in an importing country faced with the imposition of an environmental excise tax may argue that the resulting cost increase reduces their competitiveness vis-à-vis imported goods. In such circumstances, there will be a demand for restrictions on imports to offset this competitive disadvantage, i.e., there should be a corresponding border tax adjustment to offset the impact of the environmental tax. In principle, such border tax adjustments do not contravene GATT/WTO guidelines: Articles III and XVI of GATT allow contracting parties to adjust excise taxes on imported products up to the same level as those applied on domestic products, i.e., taxes on imported goods imposed on the same basis as domestic excise taxes are not regarded as being discriminatory.¹

Bagwell and Staiger (2001a; 2001b) have addressed this issue more formally in terms of the debate over whether the WTO/GATT is unfriendly to environmental concerns.² There is a commonly held fear that, due to pressures of maintaining international competitiveness, countries will compromise on enforcing strict environmental standards, i.e., governments will either resist setting tougher regulations, what Bagwell and Staiger (2001a) term “regulatory chill”, or they may even set less restrictive regulations, the so-called “race to the bottom”. Based on a specific theoretical model of GATT (Bagwell and Staiger, 1999), they argue that these types of problems can be resolved through the existing WTO/GATT rules. In the context of their model, the conflict between negotiated tariff reductions and incentives to introduce environmental regulations can be

seen as one of how to secure “property rights over negotiated market access commitments” (Bagwell and Staiger, 2001a: 19). Negotiated market access can be reduced in two ways: first, a country may feel constrained from unilaterally raising its tariffs because of WTO/GATT obligations, and, instead chooses unilaterally to lower domestic standards, thus improving the competitive position of domestic firms; second, a country may raise its domestic standards, and then raise tariffs by more than that necessary to offset the competitive effect of the higher standards. In order to resolve this problem, Bagwell and Staiger (2001b) argue that, though a country can set any domestic standards it wishes, in order to deal with increased import competition, it needs to address market access through its tariff policy in a manner that maintains negotiated levels of market access. This amounts to allowing governments both increased sovereignty over their domestic regulatory choices and also a way of meeting their international trading obligations. As noted above, the WTO/GATT rules already allow for such a response under GATT Article III. Countries are permitted to set border tax adjustments to offset the impact of increased market access arising from higher domestic environmental taxes.³ Specifically, countries imposing border tax adjustments in excess of the domestic tax would be regarded as acting in a discriminatory manner and hence in contravention of Article III.

While the rationale for border tax adjustments for environmental excise taxes is clear cut, the case where the environmental excise tax is applied to an intermediate good but it is the final good that is imported is a less straight-forward case. Nevertheless the competitiveness issue still arises: domestic producers of the final good face an increase in the cost of intermediate inputs due to the environmental excise tax which places them at a disadvantage vis-à-vis final imported goods where the cost of intermediates is lower in the absence of the environmental tax. In such cases, the border tax adjustment relates to the final derivative imported good. Since environmental excise taxes are typically targeted at intermediate-producing sectors, the appropriate treatment of imported final goods is clearly a relevant issue. This issue is also addressed in the GATT/WTO framework: as Davie (1995) reports, GATT/WTO rules extend to border tax adjustments of imported derivative products when the environmental excise tax is imposed on intermediates. A GATT Panel has

confirmed the application of border taxes on the derivative product when the domestic tax is imposed on upstream producers.⁴

This paper focuses on the use of environmental excise taxes imposed on domestic intermediate goods and the appropriate tax treatment of imported final products that use the intermediate input but yet remain untaxed in the exporter's country. We should note that in the context of GATT/WTO rules, border adjustments are not motivated by environmental concerns but, as Demaret and Stewardson (1994, p.14) note, "to preserve competitive equality in international trade." However, given the potential for mercantilist protectionism, and the need to maintain negotiated market access commitments, identifying the likely effect of border tax adjustments on trade flows is of obvious importance. If both the intermediate and final sectors were perfectly competitive, the appropriate treatment for imports would be relatively straightforward: an import tax on the final good equal to the level of the environmental excise tax times the extent to which the intermediate good enters the domestic downstream firm's cost function, would raise marginal costs for the importer by the same amount, and consequently will have a neutral effect on imports (Poterba and Rotemberg, 1995). This treatment of imported derivative products broadly matches border tax adjustments as currently applied in the United States. If intermediate and final goods markets are oligopolistic, however, taxing imported final goods at the same level as the environmental excise tax on domestic intermediates will have a non-neutral impact on imports. As will be shown, the role of firm behavior, i.e., whether firms follow Cournot or Bertrand strategies, will determine the extent of non-neutrality.

Introducing imperfect competition into the analysis highlights a potential source of conflict between those concerned with non-discriminatory trade barriers and those concerned with the environment. International economists often use the notion of 'neutrality' or 'equivalence' in assessing alternative trade policy instruments, i.e., that the level or form of trade policy instruments result in the same limitation on imports. When markets are imperfectly competitive, the issue of 'neutrality' is more difficult to assess as trade and environmental policy instruments have potentially different effects compared with a perfectly competitive

market setting. As will be shown in this paper, deviating from the assumption of perfect competition will likely result in lower border tax adjustments for the domestic environmental excise tax if the principle of ‘neutrality’ in trade is to be upheld; as will be shown, in some cases, maintaining the principle of ‘neutrality’ may justify an import subsidy as the appropriate border adjustment. This issue of the appropriate border tax adjustments for domestic environmental excise taxes arises due to the purpose of these border taxes under GATT/WTO statutes, i.e., that border taxes can be used but should not be discriminatory, and assumptions about market structure in up- and downstream sectors.

Adhering to the principle of ‘neutrality’, therefore, has the potential to create tension between environmentalists and trade experts for two reasons. First, environmentalists would argue that such taxes are required to influence production and/or consumption decisions in order to improve environmental quality. The GATT/WTO agenda is not focused on environmental concerns *per se* but rather trade and, specifically, how environmental policies may affect trade flows. As Demaret and Stewardson (*op. cit.*, p.7) state, since the border tax adjustments are, “simply to equalize competitive conditions in international trade [t]hese rules do not always fit comfortably with the situation where domestic taxes are used to achieve a particular policy goal.....such as environmental protection.” Second, even if environmentalists accepted in principle the need for border tax adjustments, as we show in this paper, when markets are imperfectly competitive, domestic environmental excise taxes could be matched by lower border tax adjustments or even import subsidies on foreign goods if the GATT/WTO statutes are to be upheld.

As far as GATT/WTO rules are concerned, there are two *caveats* relevant for discussion in this paper. First, GATT/WTO does not define what border tax adjustments are meant to “equalize” with respect to trade, i.e., whether it is the level of imports or the share of imports. Using Bagwell and Staiger’s (2001a) language, the rules are not clear about exactly what is meant by maintaining market access. As is well-known from the international economics literature, how neutrality is defined is likely to matter. Second, environmental policy can be either in the form of excise taxes on certain goods or inputs or in the form of taxes on certain production

processes which may contribute to environmental pollution. Examples of environmental excise taxes would include a fuel tax, a tax on leaded gasoline, a tax on ozone-depleting chemicals, and so on. Examples of environmental process taxes include taxes on emissions, waste disposal and water effluent. Clearly both forms of taxes have the same intent, i.e., to influence production/consumption decisions so that environmental damage is reduced. However, even though both forms of tax may affect trade flows, GATT/WTO statutes permit only border tax adjustments for excise taxes *not* process taxes. As Demaret and Stewardson (*op. cit.*) note, this dates back to the original formulation of GATT rules when it was generally believed that indirect taxes were shifted forward while direct taxes were not: thus, border tax adjustments would apply only when environmental excise taxes were used but would not be permitted for any other form of environmental legislation.⁵ As noted in a recent WTO newsletter (WTO, 1997), this has led to several WTO member countries arguing that existing GATT/WTO statutes on border tax adjustments are no longer valid due to the increased importance of environmental concerns among WTO signatories. Again, this is an issue which may bemuse those explicitly concerned with environmental policy. Whatever the inadequacies of current GATT/WTO statutes, however, for the purposes of this paper the focus will be on the appropriate border tax adjustments for domestic environmental excise taxes, and how they affect trade.

The paper is organized as follows. In section 2, the use of domestic environmental excise taxes and the nature of border tax adjustments applied in the US are reviewed. The theoretical framework which allows for oligopoly at both final and intermediate stages, i.e., successive oligopoly, is introduced in section 3. Taking as the appropriate benchmark(s) the expectation that border tax adjustments should have *either* a neutral effect on the volume of imports of final goods, *or* a neutral effect on the market share of imports, the way in which market structure determines the existence and extent of non-neutrality is explored in section 4.⁶ We also show that border tax adjustments can impact on firm's profits even when the border tax is set such as to keep imports at the original level. Domestic firms will lose out even if the when a combination of environmental taxes and border tax adjustments are used even if the level of negotiated market access remains unchanged. A summary

of the paper and conclusions are presented in section 5.

2. Environmental Excise Taxes and Border Tax Adjustments in the United States and European Union

The GATT/WTO framework is specific about the type of taxes that can be subject to border tax adjustments. In a recent report by the WTO Committee on Trade and the Environment, the distinction between direct and indirect taxes was made with direct taxes imposed directly on producers not being subject to border tax adjustments while indirect taxes, i.e., taxes imposed directly or indirectly on the product, are (WTO, 1997). Although the relevance of this distinction has been questioned, and arguably discriminates against countries that rely more on direct taxation, the distinction remains as the basic principle of the GATT/WTO rules on border tax adjustments.⁷ In addition, a distinction is made between the origin and destination principle with the destination principle being the principle underlying GATT rules on border tax adjustments.

A range of excise taxes have been and are currently applied in the United States targeted to various environmental objectives. For example, the so-called LUST tax is imposed on motor fuels, applied at a rate of \$.001 per gallon of gasoline, to pay for environmental damage associated with leaking underground tanks.⁸ A Superfund tax on petroleum, at a rate of \$.147 per barrel, was used to fund the Oil Spill Liability Trust and a fund for dealing with toxic waste sites. Dealing with toxic waste was also the primary purpose of the tax on toxic chemicals, ranging from a rate of \$.22 to \$4.87 per tonne, while the tax on ozone-depleting chemicals, principally chlorofluorocarbons (CFCs), applied at a base rate of \$3.35 which is increased by a dollar each year, is aimed at restricting the use of CFCs as a manufacturing input (see Barthold, 1994, for a discussion). Davie (*op. cit.*) reports that, taken together, these environmental excise taxes were expected to raise \$2 billion per year in the mid-1990s. With the exception of the LUST tax, which is imposed on motor fuels in general, these environmental taxes include/have included provisions for border taxes on imported (derivative) products. In the case of the Superfund tax, for example, imports of petroleum products were taxed at the same per barrel rate as crude oil received by US refineries.⁹

In the case of the legislation dealing with the tax on CFCs, imported products containing CFCs are taxed on the basis of the weight of CFCs contained in the product with the extent of CFC used determined by the predominant method of US production. The regulations governing the use of the Superfund tax on toxic chemicals also detailed the treatment of derivative products: imported substances were taxed at the rate that would have been imposed by the chemical tax had the substance been produced in the United States.

Excise taxes are also widely used by many European countries. The list of taxes is similar to that for the United States with environmental excise taxes on fuel applied in almost all EU countries. Carbon taxes are also used in Austria, Denmark, Finland, and the Netherlands. Majocchi (2001) also noted recent European Commission initiatives for taxing energy products while Italy has also considered the Italian government's proposals for carbon/energy taxes either as part of European-wide initiatives or as unilateral policies. Several European countries also have taxes applied to deal toxic waste and the disposal of environmental damaging goods including CFC charges applied in Denmark.

In principle, border tax adjustments for domestic environmental excise taxes should have a neutral effect on imports of the final product.¹⁰ If the intermediate and final good producing sectors are imperfectly competitive however, this may not necessarily be the case. For example, casual inspection of the set of industries covered by the CFC border tax indicates that several of these industries, e.g., automobiles, heavy trucks, photocopiers and refrigerators, may be less than perfectly competitive (see Table 3 of Davie, *op. cit.*). In the remainder of the paper the issue of (non-) neutrality is explored in the context of imperfectly competitive markets.

3. Theoretical Framework

Assumptions

The model introduced here is one of successive oligopoly, i.e., both the upstream (intermediate) and downstream (final) stages are imperfectly competitive. At the downstream stage, the domestic firm competes

with a foreign exporter of the final product. In the domestic upstream stage, two firms produce the intermediate input which is assumed to be homogenous. Although the foreign upstream stage can have the same structure, this sector is ignored in the present case. The domestic intermediate sector uses the environmentally-harmful input; consequently, the environmental excise tax raises the intermediate firms' costs, which subsequently raises the downstream firm's costs due to the price of the intermediate good. The technology linking each stage is one of fixed proportions. Formally, $x_1 = \phi x^U$, where x_1 and x^U represent output in the domestic downstream and upstream stages respectively, and where ϕ is the constant coefficient of production.¹¹ To ease the exposition, ϕ is set equal to one in the framework outlined below. Arm's length pricing between the downstream and upstream stages is also assumed, i.e., the downstream stage takes input prices as given.

In terms of the game-theoretic structure of the model, the timing of the firm's strategy choice goes from upstream to downstream. Specifically, given costs and the derived demand curve facing the upstream sector, an upstream firm will maximize profits contingent on a conjecture of how the other upstream firm will respond. This generates Nash equilibrium at the upstream stage. The intermediate input prices are taken as given by the domestic downstream firm which maximizes profits contingent on their expectation of how their foreign competitor will respond, thus giving Nash equilibrium at the downstream stage. Although it is common to assume a particular firm strategy, the general model introduced below allows us to identify the role of Cournot and Bertrand strategies in determining the outcome. In terms of solving the model, equilibrium at the downstream stage is derived first and then the upstream stage.

Equilibrium in the Downstream Market

The model is written in general form following Dixit (1986). Let x_1 equal output of the domestic downstream firm and x_2 the output of its foreign competitor. The revenue functions can be written as:

$$R_1(x_1, x_2) \tag{1}$$

$$R_2(x_1, x_2) . \tag{2}$$

We assume downward sloping demands and substitute goods.

Given (1) and (2), the relevant profit functions are given as:

$$\pi_1 = R_1(x_1, x_2) - c_1 x_1 \tag{3}$$

$$\pi_2 = R_2(x_1, x_2) - c_2 x_2, \tag{4}$$

where c_1 and c_2 are the domestic and foreign firms' respective costs. Firms' costs relate to the purchase of the intermediate input.

The first-order conditions for profit maximization are given as:

$$R_{1,1} + v_1 R_{1,2} = c_1 \tag{5}$$

$$R_{2,2} + v_2 R_{2,1} = c_2 , \tag{6}$$

where v_1 and v_2 are the conjectural variations parameters for each firm. While the much-warranted criticisms of conjectural variations are acknowledged, our use of them here is restricted to comparing Cournot and Bertrand outcomes in a consistent framework; as shown below, the Bertrand-equivalent strategies in quantity-space imply a conjecture in quantities less than the value for the Cournot conjecture.¹²

In the case of Cournot conjectures, each firm believes that its rival will not change output in response to a change in its own output, i.e.,

$$v_i = dx_j / dx_i = 0 \quad i = 1, 2, \quad j \neq i. \tag{7}$$

For the purposes of the presentation here, all that is required to compare the Cournot with the Bertrand outcome is that, in quantity-space, the value for v_i will be less than zero when the goods are imperfect substitutes. Specifically, for the Bertrand case, each firm believes that when it increases its output, the other firm will reduce its output by just enough to keep its own price constant. The direct demand functions for the two firms are defined as:

$$D_1(p_1, p_2) \quad (8)$$

$$D_2(p_1, p_2), \quad (9)$$

where p_1 and p_2 are their respective prices. The conjectural variations terms can be derived by totally differentiating the demand functions (8) and (9):

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \begin{bmatrix} D_{1,1} & D_{1,2} \\ D_{2,1} & D_{2,2} \end{bmatrix} \begin{bmatrix} dp_1 \\ dp_2 \end{bmatrix}. \quad (10)$$

As Bertrand conjectures imply that each firm believes its rival will hold price constant in response to a change in its own price, the conjectural variations parameter is defined as:

$$v_i = \left[\frac{dx_j}{dp_i} \bigg/ \frac{dx_i}{dp_i} \right]_{dp_j = 0} = \frac{D_{j,i}}{D_{i,i}} \quad i = 1, 2, \quad j \neq i, \quad (11)$$

where $v_i < 0$ for imperfect substitutes, and $v_i = -1$ for perfect substitutes.

Equilibrium in the downstream stage can be derived by totally differentiating the first-order conditions (5) and (6):

$$\begin{bmatrix} R_{1,11} + v_1 R_{1,21} & R_{1,12} + v_1 R_{1,22} \\ R_{2,21} + v_2 R_{2,11} & R_{2,22} + v_2 R_{2,12} \end{bmatrix} \begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \begin{bmatrix} dc_1 \\ dc_2 \end{bmatrix}. \quad (12)$$

The slopes of the reaction functions are found by implicitly differentiating the firms' first-order conditions:

$$\frac{dx_1}{dx_2} = r_1 = -(R_{1,12} + v_1 R_{1,22}) / (R_{1,11} + v_1 R_{1,21}) \quad (13)$$

$$\frac{dx_2}{dx_1} = r_2 = -(R_{2,21} + v_2 R_{2,11}) / (R_{2,22} + v_2 R_{2,12}). \quad (14)$$

For a Cournot game with substitute goods, the reaction functions will be downward sloping in quantity space, i.e., $r_i < 0$. For a Bertrand game with substitute goods, upward sloping reaction functions in price space are

implied by $r_i > 0$, i.e., each firm responds to an output increase (price cut) of its rival by raising its output (cutting price).¹³

Given (12), the solution to the system is found by re-arranging in terms of dx_i and inverting where Δ is the determinant of the left-hand side of (12):

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \Delta^{-1} \begin{bmatrix} R_{2,22} + v_2 R_{2,12} & -(R_{1,12} + v_1 R_{1,22}) \\ -(R_{2,21} + v_2 R_{2,11}) & R_{1,11} + v_1 R_{1,21} \end{bmatrix} \begin{bmatrix} dc_1 \\ dc_2 \end{bmatrix}. \quad (15)$$

This can be simplified to:

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \Delta^{-1} \begin{bmatrix} a_2 & b_1 \\ b_2 & a_1 \end{bmatrix} \begin{bmatrix} dc_1 \\ dc_2 \end{bmatrix}, \quad (16)$$

where,

$$a_1 = (R_{1,11} + v_1 R_{1,21}) \quad a_2 = (R_{2,22} + v_2 R_{2,12})$$

$$b_1 = (R_{1,12} + v_1 R_{1,22}) \quad b_2 = (R_{2,21} + v_2 R_{2,11}).$$

As Dixit (*op. cit.*) has shown, for stability of the duopoly equilibrium, the diagonal of the matrix has to be negative, i.e., $a_i < 0$, and the determinant positive, i.e., $\Delta = (a_1 a_2 - b_1 b_2) > 0$. Given these conditions, further comments can be made about the reaction functions. $r_i = -(b_i)/a_i$ from (13) and (14). Hence, if $a_i < 0$, then for Cournot conjectures $b_i < 0$, in order to satisfy $r_i < 0$, and $b_i > 0$ in order to satisfy $r_i > 0$ for Bertrand conjectures. The expression for r_i can be substituted into (16) in order to make the comparative statics easier to follow:

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \Delta^{-1} \begin{bmatrix} a_2 & a_1 r_1 \\ a_2 r_2 & a_1 \end{bmatrix} \begin{bmatrix} dc_1 \\ dc_2 \end{bmatrix}. \quad (17)$$

Equilibrium in the Upstream Market

Given the fixed proportions technology and $\phi = 1$, total output in the domestic upstream sector is given by $x^U (= x_1)$. It is assumed that there are two upstream firms (*A* and *B*) whose combined output equals x^U , i.e.,

$x_A + x_B = x^U$. The intermediate good is assumed to be homogeneous so that the downstream firm is indifferent about the relative proportions of x_A and x_B used in its production process. Assuming that the downstream firm faces no costs other than the price paid for the intermediate input, the inverse derived demand function facing firms in the upstream sector can be found by substituting p_1^U for c_1 in (5) where superscript U denotes the upstream sector. Firms' profits in the upstream sector are, therefore, given by:

$$\pi_A^U = R_A^U(x_A, x_B) - c_A^U x_A \quad (18)$$

$$\pi_B^U = R_B^U(x_A, x_B) - c_B^U x_B, \quad (19)$$

where c_A^U and c_B^U are the upstream firms' costs respectively.

Given this, the equivalent of (17) can be re-written for the domestic upstream market:

$$\begin{bmatrix} dx_A^U \\ dx_B^U \end{bmatrix} = (\Delta^U)^{-1} \begin{bmatrix} a_B^U & a_A^U r_A^U \\ a_B^U r_B^U & a_A^U \end{bmatrix} \begin{bmatrix} dc_A^U \\ dc_B^U \end{bmatrix}. \quad (20)$$

4. Environmental Excise Taxes, Border Taxes and Non-Neutrality

The imposition of the environmental excise tax t^e at the domestic intermediate stage raises both c_A^U and c_B^U . In turn, this raises the price of the intermediate good, i.e., the costs to the domestic downstream firm c_1 . The cost increase to the domestic downstream firm also affects imports. This is given by dx_2/dc_1 . The border tax adjustment targeted at the downstream firm's foreign competitor directly raises their costs which, in turn affects the level of imports. This is given by dx_2/dc_2 . Since the GATT/WTO guidelines are unclear, the neutral border tax adjustment (*neutral BTA*) is defined as *either* the change in c_2 that keeps the volume of imports constant given the environmental tax t^e , *or* as the change in c_2 that keeps the domestic market share of imports constant given t^e .

Import-Volume Neutrality

If neutrality is defined in terms of import volume, the appropriate border tax is given as:

$$\text{neutral BTA} = \frac{(dx_2/dc_1) t^e}{-(dx_2/dc_2)}. \quad (21)$$

When markets are competitive, then the absolute value of $dx_2/dc_2 = dx_2/dc_1$, so that the net effect is such that $dx_2 = 0$. Consequently, the appropriate border tax should equal the level of the environmental excise tax, t^e . However, when markets are imperfectly competitive, setting the import tax equal to the environmental excise tax will lead to a non-neutral outcome, $dx_2 \neq 0$.

Non-Neutrality with Bertrand Behavior

Consider first of all the effect of the import tax on the imports of the final good. Using (17):

$$dx_2 = \Delta^{-1} a_1 dc_2. \quad (22)$$

Since $\Delta^{-1} > 0$ and $a_1 < 0$, the border tax (as expected) reduces the level of imports, i.e., $dx_2 < 0$.

Then consider the impact of the environmental excise tax (which raises c_1) on imports using (17):

$$dx_2 = \Delta^{-1} a_2 r_2 dc_1. \quad (23)$$

Since $\Delta^{-1} > 0$ and $a_2 < 0$, the effect of the domestic excise environmental tax depends on the sign of r_2 . As noted above, with Bertrand behavior, the reaction function is upward sloping, i.e., $r_2 > 0$. Consequently, the right-hand side of (23) is negative which suggests that the environmental excise tax has a non-neutral impact on imports as it further reduces imports. Specifically, since in a Bertrand game the goods are strategic complements, the environmental excise tax imposed at the intermediate stage will reduce domestic output at the final stage *and* imports. Consequently, with Bertrand behavior, since $dx_2/dc_1 < 0$, to restore neutrality, the appropriate policy is an import *subsidy* rather than an import tax.

Non-neutrality with Cournot Behavior

Refer back to (23). With Cournot behavior, $r_2 < 0$, which results in $dx_2/dc_1 > 0$. Whether the expansion of imports matches the contraction due to the import tax depends on two factors: the effect of the change in costs on the final market, and the extent to which the domestic environmental tax, t^e , is transmitted into an increase in the downstream firm's costs, dc_1 . Focusing, first of all, on the former, even if $dc_1 = dc_2$, the impact of the domestic environmental tax will likely be less than the border tax. For example, if it is assumed that $a_1 \approx a_2$, since the absolute value of r_2 is less than one, $a_2 r_2 < a_1$. Second, consider the likelihood of $dc_1 = dc_2$. This depends on the incidence of the environmental excise tax on the downstream firm's cost function, i.e., $dp_1^U / (dc_A^U + dc_B^U)$, the extent to which the intermediate input price rises as a result of the domestic environmental excise tax. Since the intermediate goods are perfect substitutes, then:

$$dp_1^U = p_{1,1}^U (dx_A^U + dx_B^U). \quad (24)$$

Using (20):

$$dp_1^U = p_{1,1}^U \left\{ (\Delta^U)^{-1} \left[dc_A^U a_B^U (1 + r_B^U) + dc_B^U a_A^U (1 + r_A^U) \right] \right\}. \quad (25)$$

As is well-known from the tax incidence literature, see for example Seade (1985), Myles (1987) and Stern (1987), there is likely to be 'under-shifting' of taxes when markets are oligopolistic. Consequently, with import taxes imposed at the same level of the domestic environmental excise tax, since $dc_2 > dc_1$ this reinforces the non-neutrality effect.¹⁴

Neutral Border Tax Adjustments

Taking (21) and using (22) - (25), the neutral border tax adjustment for the domestic environmental excise tax, can generally be given as (assuming $a_1 \bullet a_2$):

$$neutral\ BTA = -r_2 p_{1,1}^U (\Delta^U)^{-1} \left[a_B^U (1 + r_B^U) + a_A^U (1 + r_A^U) \right] t^e = -r_2 d_{c_1}. \quad (26)$$

It is clear that the form of the border tax adjustment, i.e., whether it is an import tax or subsidy, depends on the nature of competition in the downstream market. Further, even if a border tax was appropriate,

i.e., with Cournot behavior, the level of the border tax will depend on the nature of competition in both the upstream and downstream markets. When under-shifting occurs, the border tax that restores neutrality should be less than the level of the environmental excise tax. Intuitively, the reason for this is that with Bertrand behavior, the domestic environmental tax reduces domestic downstream sales *and* imports. Therefore, in order to maintain their negotiated market access commitments, an import subsidy is the appropriate policy. In the case of Cournot behavior, the tax reduces domestic sales but increases imports. In order to maintain market access at negotiated levels, an import tax is justified. However, since the increase in imports is less than the decline in domestic sales, the border tax adjustment should be less than the corresponding domestic environmental tax.

Import-Share Neutrality

In the case of import-share neutrality, the appropriate border tax rule is defined as one where the net effect of the environmental tax t^e on x_1 and x_2 must equal the net effect of the border tax adjustment on x_1 and x_2 :

$$t^e [(d_{x_2}/d_{c_1}) + (d_{x_1}/d_{c_1})] = BTA [(d_{x_1}/d_{c_2}) + (d_{x_2}/d_{c_2})]. \quad (27)$$

Re-arranging (27), the neutral BTA is defined as:

$$neutral\ BTA = \frac{t^e [(d_{x_2}/d_{c_1}) + (d_{x_1}/d_{c_1})]}{[(d_{x_1}/d_{c_2}) + (d_{x_2}/d_{c_2})]}, \quad (28)$$

and substituting in from (17):

$$neutral\ BTA = \frac{(a_2 r_2 + a_2) t^e}{(a_1 r_1 + a_1)}. \quad (29)$$

Assuming that $a_1 \approx a_2$, the neutral BTA is defined as:

$$neutral\ BTA = \frac{(r_2 + 1) t^e}{(r_1 + 1)} = \frac{(r_2 + 1) d_{c_1}}{(r_1 + 1)}. \quad (30)$$

In this case, defining ‘maintained market access’ in terms of market shares does not lead to the ‘sign’ of the policy being dependent on the nature of firm behavior. In this case, since the domestic environmental tax will reduce the market share of the downstream firm, a border tax is the appropriate adjustment to make in both cases.

Non-neutrality with Cournot and Bertrand Behavior

In the case of Cournot behavior, $r_i < 0$, and given that $|r_1| > |r_2|$, the appropriate border tax adjustment exceeds that for the case of import-volume neutrality as given in (26), but still depends on the extent of ‘under-shifting’ of the environmental tax as reflected in the change in the domestic downstream firm’s costs dc_1 . For Bertrand behavior, $r_i > 0$, and given that $|r_1| > |r_2|$, the appropriate border tax adjustment is now a tax, as opposed to a subsidy in the import-volume case. Note, however, that in the Bertrand case, the *neutral BTA* is lower than in the Cournot case. Hence, the nature of downstream competition still matters in the case where neutrality is defined in terms of import-share.

Border Tax Adjustments and Profit Effects

It is interesting to note that while appropriate border tax adjustments can be defined in the presence of imperfect competition, the downstream profit effects of the two definitions of neutrality are quite different.¹⁵ This is important since even though the appropriate border tax adjustment will keep imports at the same level, re-distribution of profits between domestic and foreign firms can still occur. Specifically, in the case of *import-volume neutrality*, the combination of the environmental tax and border tax adjustment shifts profits away from the domestic firm to the foreign firm for the case with Cournot behavior.

In order to see this, first totally differentiate the profit functions (3) and (4):

$$d \pi_1 = R_{1,1} d x_1 + R_{1,2} d x_2 - c_1 d x_1 + \pi_{1,c_1} d c_1 \quad (31)$$

$$d \pi_2 = R_{2,2} d x_1 + R_{2,1} d x_1 - c_1 d x_1 + \pi_{2,c_2} d c_2, \quad (32)$$

and substituting in from the first-order conditions (5) and (6):

$$d\pi_1 = (-v_1 R_{1,2})dx_1 + R_{1,2}dx_2 + \pi_{1,c_1}dc_1 \quad (33)$$

$$d\pi_2 = (-v_2 R_{2,1})dx_2 + R_{2,1}dx_1 + \pi_{2,c_2}dc_2, \quad (34)$$

Given $dx_2=0$, $\pi_{1,c_1}dc_1 = -xdc_1$, and, for Cournot, $v_1=0$, it is easy to see that $d\pi_1 < 0$, i.e., domestic firm profits fall. For the foreign firm, assuming $a = a_1 \approx a_2$, (34) can be re-written as:

$$d\pi_2 = R_{2,1}dx_1 + \pi_{2,c_2}dc_2 = x_2[\Delta^{-1}p_{2,1}a(d_{c_1} + r_1d_{c_1}) - d_{c_1}], \quad (35)$$

Given $\Delta^{-1} > 0$, $p_{2,1} < 0$, $a < 0$, and $r_1 < 0$, as long as $[.] > 0$, then $d\pi_2 > 0$, i.e., foreign firm profits increase. The reason for this is that the border tax adjustment has been set appropriately, and is less than the domestic environmental tax. From figure 1, it is clear why this should be the case, i.e., in order to satisfy the *neutral BTA* rule that $dx_2=0$, it must be the case that $d\pi_1 < 0$ and $d\pi_2 > 0$. The environmental tax shifts the domestic reaction function from RF_1 to RF_1' , and the border tax adjustment shifts the foreign reaction function from RF_2 to RF_2' , such that the foreign firm's output remains at $x_2 = x_2'$. Domestic firm profits fall to π_1' , and foreign firm profits increase to π_2' .

Turning to the case of Bertrand behavior, and assuming $a = a_1 \approx a_2$, the domestic firm's profit expression (33) can be re-written as:

$$d\pi_1 = -v_1x_1p_{1,2}[\Delta^{-1}a(d_{c_1} + r_1d_{c_2}) - d_{c_1}]. \quad (36)$$

Under Bertrand, $v_1 < 0$ and $r_1 > 0$. In addition, $p_{1,2} < 0$, $a < 0$, and $dc_2 < 0$, as the optimal border instrument in this case is a subsidy. Therefore, as long as $dc_1 > |r_1dc_2|$, and $-v_1x_1p_{1,2}[.] < 0$, then $d\pi_1 < 0$. In the case of the foreign firm, (35) is the relevant expression. As long as $dc_1 > |r_1dc_2|$, and $[.] > 0$, then $d\pi_2 > 0$. The case of Bertrand behavior is somewhat ambiguous, but the same result holds if the border adjustment dc_2 is at a suitably low level.

In the case of *import-share neutrality*, the combination of the environmental tax and border tax

adjustment increases the profits of both the domestic and foreign firm with Cournot and Bertrand behavior, i.e., the combination of the two policies essentially facilitates more collusive behavior by both firms (see Salop, 1986). In order to see this, first derive dx_1 and dx_2 from (17), assuming $a = a_1 \cdot a_2$, and substituting in for dc_2 from (30):

$$d x_1 = \Delta^{-1} \left[a d c_1 \left(1 + r_1 \left\{ \frac{(r_2+1)}{(r_1+1)} \right\} \right) \right] \quad (37)$$

$$d x_2 = \Delta^{-1} \left[a d c_1 \left(r_2 + \left\{ \frac{(r_2+1)}{(r_1+1)} \right\} \right) \right]. \quad (38)$$

As $\Delta^{-1} > 0$, $a < 0$, $dc_1 > 0$, and for Cournot behavior, $r_i < 0$, then $dx_1 < 0$ and $dx_2 < 0$. For Bertrand behavior, $r_i > 0$, so again, $dx_1 < 0$ and $dx_2 < 0$.

Substituting (37) and (38) into (33) and (34):

$$d \pi_1 = x_1 d c_1 \left\{ p_{1,2} \Delta^{-1} a \left[(r_2 - v_2) + (1 - v_1 r_1) \left(\frac{r_2+1}{r_1+1} \right) \right] - 1 \right\} \quad (39)$$

$$d \pi_2 = x_2 d c_2 \left\{ p_{2,1} \Delta^{-1} a \left[1 - v_1 r_2 + (1 + r_1) \left(\frac{r_2+1}{r_1+1} \right) \right] - 1 \right\}. \quad (40)$$

For the case of Cournot, $v_i = 0$, and, $r_i < 0$. In addition, in (39), $p_{1,2} < 0$, $\Delta^{-1} > 0$, $a < 0$, and $[\cdot] > 0$, while in (40), $p_{2,1} < 0$, $\Delta^{-1} > 0$, $a < 0$, and $[\cdot] > 0$. Therefore, as long as $p_{1,2} \Delta^{-1} a [\cdot] > 1$ in (39), and $p_{2,1} \Delta^{-1} a [\cdot] > 1$ in (40), then $d\pi_1 > 0$ and $d\pi_2 > 0$. This result is illustrated in figure 1. The environmental tax shifts the domestic reaction function from RF_1 to RF_1' . In this case, the border tax adjustment shifts the foreign reaction function from RF_2 to RF_2'' , such that domestic and foreign firm market shares, net of the environmental tax and *neutral BTA*, remain constant along the ray from the origin. Domestic firm profits increase to π_1'' , and foreign firm profits increase to π_2'' . In the case of Bertrand behavior, $v_i < 0$, and, $r_i > 0$. Therefore, as long as $p_{1,2} \Delta^{-1} a [\cdot] > 1$ in (39), and $p_{2,1} \Delta^{-1} a [\cdot] > 1$ in (40), then $d\pi_1 > 0$, and $d\pi_2 > 0$. Again the Bertrand case is somewhat

ambiguous, but the same result will likely hold.

In summary, for *import-volume neutrality*, with Cournot, and possibly Bertrand behavior, the domestic firm suffers a loss in profits while the foreign firm gains. For *import-share neutrality*, both domestic and foreign firms benefit from an increase in profits under Cournot, and possibly under Bertrand behavior. The political-economic implication is that the domestic firm has an incentive to lobby its government to define a *neutral BTA* in terms of import share rather than import volume.

4. Summary and Conclusions

The treatment of imports is a common consideration when environmental excise taxes are imposed in the domestic market. Even when the environmental excise tax is targeted at intermediate goods, adjustments to the border taxes on final (derivative) products are usually made explicit in the relevant legislation. Clearly the purpose of border tax adjustments is to ensure that domestic firms are not placed at a competitive disadvantage vis-à-vis foreign exporters due to the imposition of environmental excise taxes. Foreign exporters also have an interest in the setting of border tax adjustments to ensure that they are not used as protectionist instruments.

A priori, one would expect a neutral outcome, i.e., the border tax adjustments for environmental taxes should leave either the volume of imports or the market share of imports of the final good unchanged. This is consistent with recent work by Bagwell and Staiger (*op.cit.*) regarding the issue of regulatory ‘chill’ and maintaining market access when domestic governments are concerned with domestic environmental policy but which may have an effect on market access. In large part, border tax adjustments will depend on how ‘market access’ is defined and the nature of firm behavior. In this paper we have shown that when both the upstream and downstream markets are imperfectly competitive, non-neutrality is likely to result. When firms play Cournot strategies, an import tax set at the level equal to the environmental excise tax is likely to be too high, irrespective of the definition of neutrality. When firms play Bertrand strategies, the border adjustment is likely to be of the wrong form when neutrality is defined in terms of import volume. In other words, an import

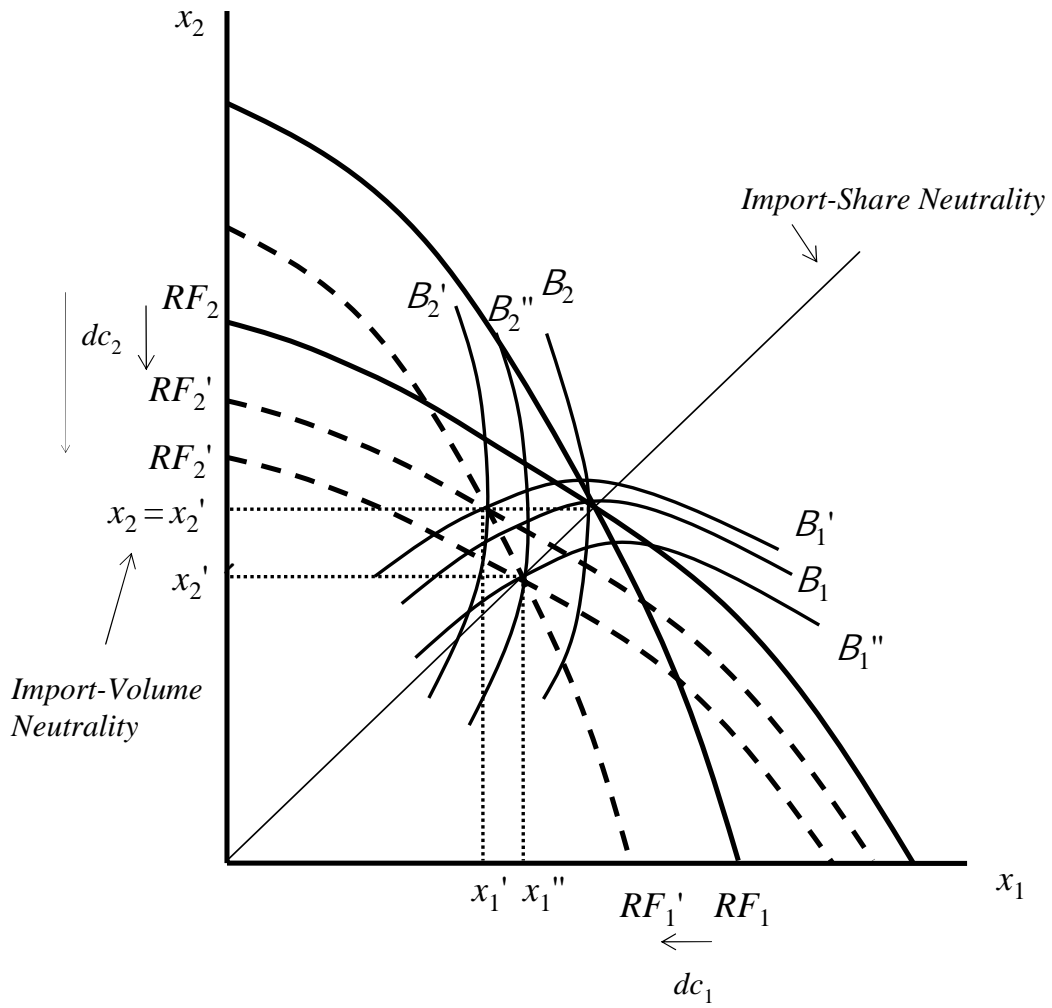
subsidy rather than a tax is the appropriate policy to ensure neutrality. In contrast, when neutrality is defined in terms of import market share, the appropriate border instrument is a tax. Moreover, these policies can leave domestic firms worse off even if the level of market access is maintained at negotiated levels. The overall conclusion is clear: market structure considerations in both final and intermediate sectors are important in setting the form and level of border tax adjustments for environmental excise taxes if the authorities are to avoid being unwittingly protectionist. When markets are imperfectly competitive, even setting border tax adjustments equal to the level of the domestic environmental tax is likely to be discriminatory.

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Figure 1: Profit Effects of Neutral Border Tax Adjustments



¹ In this paper, the focus is on border tax adjustments on imports. However, environmental tax legislation usually allows exemption from domestic environmental taxes when the good is being exported. This implicit subsidy is also legitimate in the context of the GATT/WTO framework.

² Other recent papers that have focussed on the links between domestic environmental policy and trade policy include Anderson (1998). Ederington (2001) also considers issues relating to the co-ordination of trade and domestic policies in the context of GATT/WTO rules.

³ In fact, the issue of border adjustments for domestic taxes has been long-recognized, Ricardo noting: “In the degree then in which [domestic] taxes raise the price of corn, a duty should be imposed on its importation . . . By means of this duty . . . trade would be placed on the same footing as if it had never been taxed” (Sraffa, 1953).

⁴ See GATT Panel report on ‘United States-Taxes on Petroleum and Certain Imported Substances’ June 1987 (BISD 34S/136).

⁵ Bagwell and Staiger (2001b) suggest that current GATT/WTO rules be changed so that a country can raise its border tax in response to any domestic policy that increases market access. See proposition 4 in Bagwell and Staiger (2001b).

⁶ These definitions of (non-)neutrality are consistent with the justification for border tax adjustments in the context of GATT/WTO rules. Article III of GATT states that border tax adjustments may not be applied to imported goods so as to afford protection to domestic producers.

⁷ As noted above, the GATT/WTO framework also makes allowances for rebates on exported goods that have been subject to domestic environmental taxes. We do not consider these issues in this paper.

⁸ The data reported here relate to fiscal year 1993/94 and are discussed in greater detail in Davie (1995).

⁹ The border tax adjustment for the US Superfund tax was the subject of a GATT Panel Report in 1988 following a complaint by the European Community. While the motivation for the Superfund Tax was for environment clean-up, the European Community complaint was based on the argument that the imported derivative chemicals had been processed abroad and that there was no pollution in the US to clear up. The GATT Panel ruled that the US border tax adjustment was legitimate irrespective of the purpose for which the domestic tax was imposed. In other words, the border tax adjustment for the Superfund tax did not contravene GATT rules as long as the border tax was not used for protectionist purposes. See Demaret and Stewardson (1994) for further details.

¹⁰ Had the legislation been passed, the Clinton administration’s proposal in 1993 for a Btu tax could also have been added to this list of domestic environmental taxes. This proposed tax - aimed at cutting greenhouse gas emissions - was expected to raise \$70 billion over the period 1994-98 (Davie, *op. cit.*). Like most other domestic environmental taxes in the US, the Btu tax proposal also recommended border tax adjustments for imported products. The “imputed Btu tax” would have been imposed on imported products identified as having direct energy inputs. Esty (1984) reports that faced with GATT challenges to this border tax, the Office of the US Trade Representative advised the Clinton administration not to pursue the tax adjustment proposal.

¹¹ It is also assumed that there is no joint production. As Poterba and Rotemberg (1995) point out, in such

cases, it is not possible to prescribe the appropriate border taxes.

¹² While it is unnecessary for the key results of this paper, the conjectural parameters can be interpreted as indicating various degrees of competition (see Dixit, 1986).

¹³ Following the terminology of Bulow *et al.* (1985), when $r_i < 0$ the goods are 'strategic substitutes'; when $r_i > 0$, the goods are 'strategic complements'.

¹⁴ Of course, there is the possibility that 'over-shifting' will occur. For this to happen, the demand schedule facing the upstream firms must be sufficiently convex. However, 'under-shifting' can be regarded as the more normal outcome.

¹⁵ While this discussion is concerned only with profit-shifting as a by-product of border tax adjustments in the presence of environmental taxes, there is a literature on the explicit use of environmental policy as strategic trade policy, e.g., Conrad (1993).