AGRICULTURAL TRADE LIBERALISATION AND STRATEGIC ENVIRONMENTAL POLICY

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Abstract
We use an extended partial equilibrium trade model to derive optimal environmental policy responses to tariff reduction requirements and assess the impact of such policies on the welfare of trading partners. We find that countries which attribute preferential political weights to farmers' welfare have an incentive to implement environmental policies that deviate from the Pigouvian solution – even if production is not *de facto* linked to environmental externalities. We clarify the conditions under which trading partners do not gain from unilateral trade liberalisation if trade concessions are accompanied by strategic environmental policy changes. We postulate a role for the WTO in overseeing the process of domestic policy formulation.

Key words: trade liberalisation, strategic environmental policy, multifunctionality, agri-environmental policy, WTO

JEL classifications: D60, F11, F18, Q17

1. Introduction
Trade liberalisation and environmental protection have become predominant issues affecting world agriculture at the beginning of this century. While the main goal of freer trade is to enhance international specialization, some countries are concerned that trade liberalisation may conflict with non-trade policy objectives and thereby reduce social welfare. Such non-trade objectives include, among others, environmental protection and landscape preservation, food security, rural development or animal welfare. Some OECD countries argue that their agricultural sectors need to be supported in order to ensure the continuing delivery of environmental amenities (Latacz-Lohmann and Hodge, 2001; Potter and Burney, 2002). Other countries have expressed concern that environmental policies might be used as a substitute for conventional border protection without genuinely pursuing environmental goals (Vasavada and Warmerdam, 1998; Freeman and Roberts, 1999; Blandford et al., 2003).

The appropriateness of domestic policies targeting non-trade objectives can be judged by their impact on domestic production and international trade flows (Hooker & Caswell, 1999; Runge, 1999; Latacz-Lohmann, 2000). Problems arise when domestic policies promote non-commodity outputs which are jointly produced with agricultural commodity outputs. Such policies cannot, by their very nature, be trade-neutral. Edwards and Fraser (2001) propose that agri-environmental policy be evaluated on the basis of social benefit cost analysis and not on effects on production or trade volumes. They argue that any market or trade consequences of efficient, welfare-enhancing agri-environmental policies should not be considered trade-distorting. Such policies are considered "trade-correcting" by Latacz-Lohmann and Hodge (2001) because they efficiently internalise an externality, thereby correcting for a previously existing market failure. In practice, however, few agri-environmental policies are efficient. Policies may be poorly designed because of information deficiencies or asymmetries, or they may be strategically distorted by governments seeking to support farmers' incomes through a "green box" instrument. The focus of this paper is on the latter aspect: we investigate optimal environmental policy responses to tariff reduction requirements and assess the impact of such policies on the welfare of trading partners. Several authors have shown that large countries have strategic incentives to institute environmental policies that deviate from the Pigouvian tax or subsidy, because they can take advantage of their monopolistic price leverage in the world market (Vandendorpe, 1972; Markusen, 1975; Krutilla, 1991; Rauscher, 1994 and Peterson et. al, 2002).[1] We extend previous studies by allowing for preferential political weights to be attributed to farmers' welfare. The analysis thus captures equity considerations which have featured in many recent contributions to the literature on agricultural policy analysis (e.g. Bullock and Salhofer, 2003; Gardner, 1983, 1995; Paarlberg and Abbot, 1986; Abbot and Kallio, 1996). We demonstrate that countries which treat farmers' welfare preferentially have an incentive to implement 'distorted' environmental policies – even if production is not *de facto* linked to environmental externalities. We then move on to assess the effects of such policy responses on domestic and global welfare. The welfare effects of trade liberalisation and *strategic* environmental policy have so far only been studied by Burguet and Sempere (2003). This was within a framework of oligopolistic markets and was based on the restrictive assumption of constant marginal production costs. We extend Burguet and Sempere's analysis by considering competitive (rather than oligopolistic) markets, allowing for non-constant marginal production costs, and, most importantly, by including political weights on farmer income. We argue that this extension better reflects the characteristics of agricultural markets and agri-environmental policy. We clarify the conditions under which trading partners do not gain from unilateral trade liberalisation if trade concessions are accompanied by strategic environmental policy changes and derive conclusions for the WTO process.

The remainder of the paper is organised as follows. Section 2 sets out the model. In section 3 we derive optimal environmental policy responses to trade liberalisation, i.e. environmental policy choices that maximise an individual country's welfare. We then assess the impact on other nations' welfare of unilateral tariff reductions, when these are accompanied by strategic changes in environmental policy. We first study the welfare economics of marginal trade policy changes (section 4), before considering the abolishment of tariffs (section 5). Section 6 concludes.

2. The model

We choose a partial equilibrium trade model to analyze the welfare effects of trade-distorting agri-environmental policies. The model consists of two large countries trading in a single homogeneous agricultural good. The advantage of the bipolar trade model is that global welfare effects can be assessed easily, on the assumption that the second country (Country 2) represents the 'rest the world'. The home country (Country 1) produces quantity S_1 at cost $C_1(S_1)$. Agricultural production in Country 1 generates an environmental externality. The monetary value of that externality is denoted $E_1(S_1)$. The sign of ($\partial E_1(S_1)/\partial S_1$) is positive if the positive effects of agricultural production (e.g. provision of landscape amenities or biodiversity) outweigh the detrimental impacts (e.g. pollution, soil erosion), but is negative otherwise. We assume the utility from marginal environmental improvements to be decreasing, and the disutility from marginal pollution problems to be increasing. Hence, $\partial^2 E_1/\partial S_1^{\ 2} < 0$. We further assume that the externality is confined to Country 1 and does not spill over across national boundaries.

The agricultural good is also produced in the rest of the world (Country 2). However, in the interest of simplicity, we assume that production in Country 2 is environmentally neutral. Country 1 can fix a tariff (*T*) or offer an export subsidy *(-T)*, introduce an environmental tax (*t*) or subsidy (-*t*) linked to production, or use a combination of the two. As discussed above, we assume that policy changes occur only in Country 1. Hence, neither tax nor tariff instruments are available to Country 2.

The home country's supply $S_1(P_{S_1})$ and demand $D_1(P_{D_1})$ are defined as functions of domestic supply and demand prices, respectively, whereas Country 2's supply $S_2(P_w)$ and demand $D_2(P_w)$ are determined by the world price. We assume supply and demand curves to be well-behaved and non-concave. Hence, $\partial S_1/\partial P_{S_1}, \partial S_2/\partial P_w > 0$, $\partial D_1/\partial P_{D_1}, \partial D_2/\partial P_w < 0$ and $\partial^2 S_1/\partial P_{S_1}^{\ 2}, \partial^2 S_2/\partial P_w^{\ 2} \leq 0$, $\partial^2 D_1/\partial P_{D_1}^{\ 2}, \partial^2 D_2/\partial P_w^{\ 2} \geq 0$. Building upon these relationships, social welfare functions are defined for the home country and for the rest of the world. Country 1's welfare (W_1) comprises consumer surplus, 'producer benefit', tax revenues, tariff revenues and the value of the environmental externality: [2]

$$W_1(t,T) = \int_{\bar{P}_{D_1}}^{\infty} D_1(P_{D_1})dP_{D_1} + \lambda\left(P_{S_1} S_1(P_{S_1}) - C_1(S_1(P_{S_1}))\right) + t\,S_1(P_{S_1}) + T\left[D_1(P_{D_1}) - S_1(P_{S_1})\right] + E_1(S_1(P_{S_1})). \quad (1)$$

Distributional goals of agricultural policy are accounted for in expression (1) by means of a differential political weight (λ) attached to agricultural producers' benefits. The welfare function thus captures equity considerations which have featured in many recent contributions to the literature on agricultural policy analysis (e.g. Bullock and Salhofer 2003). For Country 2, we choose a simplified social welfare function (W_2), defined as the sum of consumer surplus and producer benefit: [3]

$$W_2(t,T) = \int_{P_w}^{\infty} D_2(P_w)\,dP_w + P_w S_2(P_w) - C_2(S_2(P_w)) \cdot \qquad (2)$$

Trade equilibrium requires excess demand in Country 1 to equal excess supply in Country 2:

$$D_1(P_{D_1}(t,T)) - S_1(P_{s_1}(t,T)) = S_2(P_w(t,T)) - D_2(P_w(t,T)) \qquad (3)$$

Transportation and transaction costs are neglected in the interest of simplicity. The margin between the home country's demand price P_{D_1} and the world price P_w is thus determined solely by the tariff rate. The differential between domestic supply (P_{S_1}) and demand prices is determined by the environmental tax rate. The model is completed by the assumption of perfect competition, implying that supply prices equal marginal production costs both at home and abroad:

$$P_w = \partial C_2 / \partial S_2 = P_{D_1} - T \qquad P_{S_1} = \partial C_1 / \partial S_1 = P_{D_1} - t \,. \qquad (4)$$

3. Optimal environmental policy response to trade liberalisation

In the following exposition, we assume that Country 1 is a net importer. We begin by formally deriving the set of trade and environmental policies that maximises Country 1's welfare in the absence of international trade agreements. We term this set the "first-best policy set" because it is derived under the assumption that Country 1 can make simultaneous use of the tax/subsidy and the tariff instruments in maximizing domestic welfare. It will serve as benchmark for assessing the welfare effects of trade liberalisation and strategic environmental policies.

The first-order condition for an interior maximum is obtained by taking the partial derivatives of the domestic welfare function W_1 with respect to the tax and tariff rates, setting these equal to zero and solving simultaneously ($\partial W_1/\partial t = \partial W_1/\partial T = 0$). Taking this rule and applying the constraints in equations (3) and (4) to simplify the result, we obtain: [4]

$$\frac{\partial W_1}{\partial t} = \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{(\alpha+\beta)} \left(-D_1 - \left(\frac{\partial E_1}{\partial S_1} + t \right) \left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta \right) + \left((\alpha+\beta) - \lambda \left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta \right) \right) \left(\frac{\partial S_1}{\partial P_{S_1}} \right)^{-1} S_1 + T\beta \right) = 0 \qquad (5)$$

and

$$\frac{\partial W_1}{\partial T} = \frac{\beta}{(\alpha+\beta)} \left((\lambda S_1 - D_1) - \frac{(\alpha+\beta) X_1}{\beta} + \left(t + \frac{\partial E_1}{\partial S_1} \right) \frac{\partial S_1}{\partial P_{S_1}} - T\alpha \right) = 0 \qquad (6)$$

where $\alpha = \partial S_1/\partial P_{S_1} - \partial D_1/\partial P_{D_1}$, $\beta = \partial S_2/\partial P_w - \partial D_2/\partial P_w$ and $X_1 = S_1 - D_1$.

Simultaneously solving equation (5) and (6) yields: [5]

$$t^{**} = -\frac{\partial E_1}{\partial S_1} + (1-\lambda) S_1 \left(\frac{\partial S_1}{\partial P_{S_1}} \right)^{-1} \qquad (7)$$

and

$$T^{**} = -X_1/\beta \qquad (8)$$

Equations (7) and (8) constitute the first-best policy set. Equation (8) shows that the first-best tariff T^{**} is identical to Bhagwati and Ramaswami's (1963) optimal tariff of international trade theory. The optimal tariff is determined by Country 1's trade flow (X_1) and the price responsiveness of foreign demand and supply (β). As Country 1 is, by assumption, a net importer ($X_1 < 0$), its optimum tariff will be positive ($T^{**} > 0$), and it will increase with the country's influence on the terms of trade.

The first-best environmental policy (equation 7) is the Pigouvian tax/subsidy rate ($-\partial E_1/\partial S_1$) if farmers' benefits are attributed the same political weight as those of consumers and taxpayers ($\lambda = 1$). However, if policy design is influenced by equity considerations ($\lambda \neq 1$), the environmental tax deviates from the Pigouvian solution. Note that, by contrast, the tariff is not affected by either the environmental externality or by political weights.

Having established this benchmark, we now turn to the question of how the optimal environmental policy changes if Country 1 faces tariff reduction requirements. With a given tariff rate being imposed exogenously, the home country can only vary its environmental tax rate to maximise its welfare. The second-best environmental tax/subsidy schedule, $t^*(T)$ denoted by one asterisk in the subsequent exposition, can be obtained by solving equation (5) for *t*:

$$t^*(T) = (1-\lambda)S_1\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-1} - \frac{\partial E_1}{\partial S_1} + (X_1 + T\beta)\left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta\right)^{-1} \quad (9)$$

It is obvious from equation (9) that the second-best environmental policy deviates from the first-best solution in (7). However, because equations (7) and (9) are evaluated at different points, a direct comparison of first-best and second-best policies is difficult. We thus pursue a different route by analyzing how marginal changes of the optimum tariff rate affect optimal environmental policy choices. This can be gauged by taking the derivative of equation (9) with respect to *T*:

$$\frac{\partial t^*(T^*)}{\partial T} = \frac{\beta}{(\alpha+\beta)}\left((1-\lambda)\left(1 - S_1\frac{\partial^2 S_1}{\partial P_{S_1}{}^2}\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-2}\right) - \frac{\partial^2 E_1}{\partial S_1{}^2}\frac{\partial S_1}{\partial P_{S_1}}\right) + \left(\frac{2\alpha\beta+\beta^2}{(\alpha+\beta)} - \frac{X_1}{\beta}\frac{\partial \beta}{\partial T}\right)\left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta\right)^{-1} \quad (10)$$

Since $\partial\beta/\partial T > 0$, equation (10) assumes a positive value for $\lambda \leq 1$ and $X_1 \leq 0$, otherwise the sign is ambiguous. This suggests that a large importing country which attributes a low weight to farmers' income ($\lambda \leq 1$) has an incentive to reduce (increase) the environmental tax (subsidy) rate as it commits to tariff reductions. Conversely, if farmer income receives preferential treatment by policy makers ($\lambda > 1$), as is the case in most developed countries, there might be an incentive for those countries to tighten their environmental standards by increasing (lowering) the environmental tax (subsidy) rate as they commit to tariff reductions. This seems paradoxical, given that farmers would generally benefit from low (high) environmental taxes (subsidies). However, it is important to note that equation (10) considers the relative change of *t*. Equation (9) indicates that the absolute value of the environmental tax (subsidy) rate will be generally lower (higher) the higher the political weight attached to farmer income. Notice also from expression (9) that, even if production is not linked to environmental externalities ($\partial E_1/\partial S_1 = 0$), a large country facing tariff reduction requirements may still introduce a production tax or subsidy which it may choose to label 'environmental', even if there are *de facto* no environmental externalities.

4. Welfare effects of marginal trade policy changes

Having established optimal environmental policy responses to tariff reductions, we now turn to the question of how trade liberalisation affects welfare in the 'rest of the world' if Country 1 offers tariff concessions while simultaneously adjusting its environmental policy. We begin by considering *marginal* trade policy changes before moving on, in the next section, to a consideration of full trade liberalisation involving abolishment of tariffs.

A welfare improvement in the rest of the world (Country 2) as a result of unilateral trade liberalisation requires the marginal welfare change induced by a tariff increase to be negative ($dW_2(t^{**}, T^{**})/dT < 0$), given that Country 1 is a net importer ($X_1 < 0$) and operates a positive tariff ($T^{**} > 0$). Taking the total differential of Country 2's welfare function, we obtain:

$$\frac{dW_2\left(t^{**},T^{**}\right)}{dT}=\frac{\partial W_2\left(t^{**},T^{**}\right)}{\partial T}+\frac{\partial W_2\left(t^{**},T^{**}\right)}{\partial t}\frac{dt}{dT} \ . \tag{11}$$

Since the first-order condition for a domestically optimal environmental policy will be maintained as Country 1 gradually opens up to freer trade, the derivative dt/dT can be derived from the equality condition:

$$\frac{\partial W_1\left(t^{**},T^{**}\right)}{\partial t}=0 \ . \tag{12}$$

Taking the total differential of both sides of equation (12), we obtain:

$$\frac{dt}{dT}=-\frac{\partial^2 W_1\left(t^{**},T^{**}\right)}{\partial T\partial t}\Bigg/\frac{\partial^2 W_1\left(t^{**},T^{**}\right)}{\partial t^2} \ . \tag{13}$$

Substituting (13) into (11) yields:

$$\frac{dW_2\left(t^{**},T^{**}\right)}{dT}=\frac{\partial W_2\left(t^{**},T^{**}\right)}{\partial T}-\frac{\partial W_2\left(t^{**},T^{**}\right)}{\partial t}\frac{\partial^2 W_1\left(t^{**},T^{**}\right)}{\partial T\partial t}\Bigg/\frac{\partial^2 W_1\left(t^{**},T^{**}\right)}{\partial t^2} \ . \tag{14}$$

The partial derivatives of W_2 with respect to *t* and *T* can be obtained from equation (2), given the constraints in equations (3) and (4):

$$\frac{\partial W_2}{\partial t}=-\frac{\partial S_1}{\partial P_{S_1}}\frac{X_1}{(\alpha+\beta)} \tag{15}$$

and

$$\frac{\partial W_2}{\partial T}=\frac{\alpha X_1}{(\alpha+\beta)} \tag{16}$$

Making selective use of equations (3), (4), (7), (8), (15), (16), equation (11) can be rearranged as:

$$\frac{dW_2\left(t^{**},T^{**}\right)}{dT}=\frac{-\frac{\partial D_1}{\partial P_{D_1}}X_1\left(\varphi+(1-\lambda)\phi\right)}{\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\left(\varphi+(1-\lambda)\phi\right)+\frac{X_1}{\beta}\frac{\partial\beta}{\partial t}(\alpha+\beta)+\beta\frac{\partial S_1}{\partial P_{S_1}}} \tag{17}$$

where $\phi=\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\left(1-S_1\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-2}\frac{\partial^2 S_1}{\partial {P_{S_1}}^2}\right)>0$ and $\varphi=\alpha+\beta-\frac{\partial S_1}{\partial P_{S_1}}\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\frac{\partial^2 E_1}{\partial {S_1}^2}>0$.

We assume supply and demand curves to be well-behaved and convex, hence $\partial\beta/\partial t<0$. This given, equation (17) assumes a negative value for any $X_1<0$ and $\lambda\leq 1$, but the sign of (17) is ambiguous for any $\lambda>1$. This formally proves the proposition that trading partners will unambiguously gain from unilateral trade concessions if and only if the country offering these concessions does not attach a higher weight to the welfare of domestic producers than to that of groups in society. This finding holds even if the country acts strategically in setting its domestic policies following trade liberalisation. If however farmers' welfare does attract a preferential weight ($\lambda > 1$), as is the case in most developed countries, trade concessions do not necessarily enhance the welfare of trading partners if these concessions are accompanied by strategic environmental policy changes.

5. Welfare effects of full trade liberalisation

We now turn to assess the welfare effects of discrete (rather than marginal) trade policy changes. How does the abolishment of tariff policy in Country 1 affect the rest of the world's welfare? We begin by assuming that Country 1 faced no trade policy restrictions and acted strategically in setting its trade and environmental policies. Consequently, it would have chosen the domestically optimal policy set (T^{**}, t^{**}) derived in section 3, resulting in Country 2's welfare $W_2^{**-**} = W_2\left(t^{**}, T^{**}\right)$. After a tariff ban ($T^o = 0$), Country 1 has an incentive to adjust its environmental tax/subsidy rate to $t^*\left(T^o\right)$, leaving Country 2 with welfare $W_2^{*-o} = W_2\left(t^*\left(T^o\right), T^o\right)$. The welfare implications for Country 2's can thus be written as:

$$W_2^{*-o} - W_2^{**-**} = \int_{t^{**}}^{t^*(T^o)} \frac{\partial W_2\left(T^o\right)}{\partial t} dt + \int_{T^{**}}^{T^o} \frac{\partial W_2\left(t^{**}\right)}{\partial T} dT \tag{18}$$

For solving the integrals in (18) we need to specify the functional form of supply, demand and environmental externality relationships. For mathematical convenience, we choose linear demand and supply functions. We further assume a constant relationship between marginal environmental quality and domestic supply changes. [6] Making selective substitutions of expressions (15) and (16), expression (18) can be rearranged as:

$$W_2^{*-o} - W_2^{**-**} = \frac{X_1\left(t^*, T^o\right)^2 - X_1\left(t^{**}, T^{**}\right)^2}{2\beta} \tag{19}$$

Given the linearity assumption for demand and supply functions, we can write

$$X_1^* - X_1^{**} = \frac{\partial X_1}{\partial t}\left(t^*\left(T^o\right) - t^{**}\right) + \frac{\partial X_1}{\partial T}\left(T^o - T^{**}\right) \tag{20}$$

where $X_1^* = X_1\left(t^*, T^o\right)$ and $X_1^{**} = X_1\left(t^{**}, T^{**}\right)$, and

$$S_1^* - S_1^{**} = \frac{\partial S_1}{\partial t}\left(t_1^*\left(T^o\right) - t^{**}\right) + \frac{\partial S_1}{\partial T}\left(T^o - T^{**}\right) \tag{21}$$

where $S_1^* = S_1\left(t^*, T^o\right)$ and $S_1^{**} = S_1\left(t^{**}, T^{**}\right)$.

Making use of equations (3), (4), (20), (21) and the mathematical expressions for T^{**}, T^o, $t^*\left(T^o\right)$ and t^{**}, we can derive:

$$X_1^* = \left(\left(-\beta(1-\lambda)\right)\left(S_1^* - S_1^{**}\right) + (2\alpha + \beta)X_1^{**}\right)\left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta\right)\left(-\frac{\partial D_1}{\partial P_{D_1}}\alpha + 2\alpha\beta + \beta^2\right)^{-1} \tag{22}$$

and

$$S_1^* - S_1^{**} = \frac{\partial S_1}{\partial P_{S_1}}\left(X_1^{**} - X_1^*\right)\left((\alpha + \beta) + (1-\lambda)\left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta\right)\right)^{-1} \tag{23}$$

Substituting (22) and (23) into equation (19) yields:

$$W_2^{*-o} - W_2^{**-**} = \frac{\beta(1-\lambda)^2\left(S_1^* - S_1^{**}\right)^2}{2\varpi^2}$$

$$-\frac{\frac{\partial D_1}{\partial P_{D_1}}\frac{\left(X_1^{**}\right)^2}{\beta\varpi^2}}{\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)}\left(\frac{\frac{\partial S_1}{\partial P_{S_1}}(1-\lambda)\beta(2\alpha+\beta)}{\left(\varpi+(1-\lambda)\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\right)}+\frac{2\beta\left(\beta^2+2\alpha^2+3\alpha\beta\right)-\frac{\partial D_1}{\partial P_{D_1}}\left(3\alpha^2+\beta^2+4\alpha\beta\right)}{2\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)}\right) \qquad (24)$$

where $\varpi = \left(\alpha + (\alpha+\beta)\beta\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)^{-1}\right) > 0$.

Expression (24) shows that the difference in Country 2's welfare following a tariff ban in Country 1, $W_2^{*-o} - W_2^{**-**}$, is unambiguously positive if $\lambda \leq 1$. Thus, provided that no preferential weights are attributed to farmers' welfare, a tariff ban will unambiguously enhance trading partners' welfare, even if a country acts strategically in setting its domestic policies in following trade liberalisation. We have thus formally proven that, given $\lambda \leq 1$, an optimal tariff policy is generally more trade distorting than strategically distorted environmental policies. This is plausible because social welfare gains for one country, through terms of trade improvements, are generally achieved at the expense of welfare losses for the rest of the world. Such terms of trade improvements are maximised by an optimal tariff.

The more interesting finding, however, is that the direction of welfare change in Country 2 following a tariff ban by Country 1 is generally ambiguous if Country 1 attaches preferential political weights to farmers' welfare. This is in accordance with the findings in the previous section which considered marginal tariff reductions. We can thus conclude with confidence that trade concessions on highly protected agricultural markets in large industrial countries do not necessarily enhance the welfare of trading partners if these countries are free to distort their environmental policies. This conclusion holds under the proviso that the country opening up to trade had previously operated an optimal tariff as per equation (8), which may or may not be a true reflection of reality.

6. Conclusions

We have derived optimal environmental policy choices in response to tariff reduction requirements and have assessed the impact of such policies on the welfare of trading partners. The analysis was based on a partial-equilibrium trade model which allowed for differential political weights to be attributed to farmers' welfare. The study was motivated by the ongoing debate about the multifunctional role of agriculture and fears expressed in that debate that countries might use multifunctionality as a pretext for introducing trade-distorting agri-environmental policies as a substitute for conventional border protection.

Our analysis suggests that such allegations may be justified to the extent that countries which attribute preferential political weights to farmers' welfare have an incentive to implement tax or subsidy schedules that substantially deviate from the Pigouvian solution. Environmental tax (subsidy) rates will be generally lower (higher) the higher the political weight attached to farmer income. More importantly, the incentive to implement such policies exists even if production is not *de facto* linked to environmental externalities. Finally, we have proven that trading partners will unambiguously gain from unilateral trade concessions if and only if the country offering these concessions does not attach a higher weight to the welfare of domestic producers than to that of other groups in society. If, by contrast, the country offering trade concessions treats farmers' welfare preferentially, as is the case in many developed countries, trade liberalisation does not necessarily enhance the welfare of trading partners if these concessions are accompanied by strategic environmental policy changes. These findings do not conflict with Edwards and Fraser's (2001) proposition that any market or trade consequences of efficient, welfare-enhancing agri-environmental policies should not be considered trade-distorting. We argue that such ideal policies are unlikely to be forthcoming in practice. Countries opening up to free trade have an incentive to institute distorted policies, which are not necessarily welfare-enhancing.

Two policy conclusions flow from these findings. First, if a country does not necessarily gain from tariff concessions offered by another country which is free to adjust its domestic environmental policies, the country should only negotiate package deals, i.e. tariff reductions combined with environmental policy commitments. One may postulate a role for the WTO to oversee the process of domestic policy formulation to ensure that the gains from trade liberalisation are not impaired by strategically motivated adjustments to domestic policies. This postulate is reinforced by the second conclusion: Given the incentive to implement domestic policies even if there are *de facto* no externalities, it seems important that the WTO establishes guidelines for distinguishing genuine policy from disguised protectionism. This may not be an easy task given that the level of demand for environmental, and particularly multifunctional, benefits is difficult to measure. Latacz-Lohmann and Hodge (2001) suggest that the level of activity (membership, budget, etc.) of non-government organizations may provide evidence of legitimate concern for some issues. Non-market valuation may also have a role to play in this process, although it cannot be sufficiently reliable and encompassing to offer the sole basis for judgement. Furthermore, domestic policies should have clearly defined objectives and should be targeted to achieve the stated objectives. However, even an optimally designed and targeted policy may, by virtue of 'joint production' be seen to have 'adverse' trade impacts. We argue that Green Box is the appropriate place in which to locate efficient agri-environmental policies – even if they appear to subsidise trade. There is no rationale for including payments to farmers through efficient agri-environmental policy in the calculation of a country's AMS. Green Box boundaries must be extended accordingly to allow policies – those meeting fairly rigid criteria, we emphasise – that enhance the multifunctional role of agriculture.

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Endnotes

[1] Kennedy (1994), Conrad (1993), Markusen *et al*. (1993), Barrett (1994), Ulph (1996), Greaker (2003) and others extended Markusen's and Krutilla's analyses by analyzing strategically optimal environmental policies within a game theoretic framework.

[2] We define the 'producer benefit' as the difference between total revenues and total costs, which differs from 'producer surplus' measuring the difference between total revenues and *variable* costs.

[3] $\overline{P}_w$ denotes the equilibrium world price.

[4] For deriving equation (5) and (6) we make use of the requirements $\partial X_1/\partial t = -\partial X_2/\partial t$ and $\partial X_1/\partial T = -\partial X_2/\partial T$, which can be obtained from equation (3).

[5] See Appendix for the second-order conditions of an interior maximum.

[6] Although linear demand functions are more likely to be convex than linear, they have been used in *theoretical* studies by, among many others, Rhode and Stegeman (2000), Tanaka (2001), Rath and Zhao (2001) and Gonzalez-Maestre and Lopez-Cunat (2001).

Appendix: Second- order conditions for the domestically optimal policy set

$$\frac{\partial^2 W_1(t^{**},T^{**})}{\partial t^2} = -\frac{\partial S_1}{\partial P_{S_1}}\frac{1}{(\alpha+\beta)^2}\left(\begin{array}{l}\left(\alpha+\beta-\frac{\partial S_1}{\partial P_{S_1}}\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\frac{\partial^2 E_1}{\partial S_1^{\,2}}\right)\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)+\frac{X_1}{\beta}\frac{\partial\beta}{\partial t}(\alpha+\beta)\\ +\beta\frac{\partial S_1}{\partial P_{S_1}}+(1-\lambda)\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)^2\left(1-S_1\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-2}\frac{\partial^2 S_1}{\partial P_{S_1}^{\,2}}\right)\end{array}\right)<0 \quad \text{(a)}$$

$$\frac{\partial^2 W_1(t^{**},T^{**})}{\partial T^2} = -\frac{\beta}{(\alpha+\beta)}\left(\begin{array}{l}\frac{1}{(\alpha+\beta)}\left((1-\lambda)\beta\frac{\partial S_1}{\partial P_{S_1}}+\alpha^2\right)+\alpha-\frac{\alpha X_1}{\beta^2}\frac{\partial\beta}{\partial T}\\ -\frac{(1-\lambda)S_1\beta}{(\alpha+\beta)}\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-1}\frac{\partial^2 S_1}{\partial P_{S_1}^{\,2}}-\frac{\partial^2 E_1}{\partial S_1^{\,2}}\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^2\frac{\beta}{(\alpha+\beta)}\end{array}\right)<0 \quad \text{(b)}$$

$$\frac{\partial^2 W_1(t^{**},T^{**})}{\partial t^2}\frac{\partial^2 W_1(t^{**},T^{**})}{\partial T^2} > \frac{\partial^2 W_1(t^{**},T^{**})}{\partial T\partial t} \quad \text{(c)}$$

where $$\frac{\partial^2 W_1(t^{**},T^{**})}{\partial T\partial t} = \frac{\beta}{(\alpha+\beta)}\left(\begin{array}{l}\frac{\partial S_1}{\partial P_{S_1}}\frac{\alpha}{(\alpha+\beta)}+\frac{\alpha X_1}{\beta\beta}\frac{\partial\beta}{\partial t}+\left(1-\frac{\partial S_1}{\partial P_{S_1}}\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\frac{1}{(\alpha+\beta)}\frac{\partial^2 E_1}{\partial S_1^{\,2}}\right)\frac{\partial S_1}{\partial P_{S_1}}\\ -(1-\lambda)\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)\frac{1}{(\alpha+\beta)}\frac{\partial S_1}{\partial P_{S_1}}\left(S_1\left(\frac{\partial S_1}{\partial P_{S_1}}\right)^{-2}\frac{\partial^2 S_1}{\partial P_{S_1}^{\,2}}-1\right)\end{array}\right)$$