Agricultural multifunctionality and trade liberalisation

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Multifonctionnalité de l'agriculture et libéralisation des échanges

Résumé – Les auteurs utilisent un modèle de commerce international en équilibre partiel pour analyser les interactions entre politiques tarifaire et environnementale en présence de bénéfices liés au caractère multifonctionnel de l'agriculture. Ils montrent que la libéralisation des échanges est sous-optimale si elle ne s'accompagne pas d'une politique environnementale efficiente encourageant la production des bénéfices liés à la multifonctionnalité. Toutefois, dans le cas d'un grand pays importateur net, la réduction des droits de douanes renforce les incitations à introduire une politique environnementale. Cette dernière incorpore une distorsion stratégique afin de compenser partiellement la baisse de droits de douane Malgré son caractère stratégique, cette politique environnementale permet d'accroître sans ambiguïté le bien-être global si elle est introduite conjointement avec une réduction des droits de douane. Les auteurs concluent que, bien que l'argument de la multifonctionnalité étaye certaines critiques de la libéralisation des échanges, il ne s'avère pas solide quand cette libéralisation induit l'introduction d'une politique environnementale.

Mots-clés : commerce agricole, multifonctionnalité agricole, politique environnementale stratégique, économie du bien-être

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Summary *– This paper employs a partial equilibrium trade model to analyse the interaction of trade and environmental policy in the context of agriculture's multifunctionality. We formally demonstrate that free trade is suboptimal if no efficient environmental policy addressing the provision of multifunctional benefits is in place. However, tariff reductions in a large net-importing country reinforce the incentive for that country to introduce environmental policy, though this policy will be strategically distorted to partly substitute for the tariff. Despite its strategic character, this environmental policy programme will unambiguously enhance global welfare if it is introduced in conjunction with tariff reductions. We conclude that, although the multifunctionality argument may lend some support to the criticism of trade liberalisation, the argument is not solid when trade liberalisation induces the introduction of environmental policy.*

Key-words: *agricultural trade, agricultural multifunctionality, strategic environmental policy, welfare economics*

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THE LIBERALISATION of agricultural trade and the increasing attention paid to agriculture's multifunctionality have given rise to tensions in recent WTO negotiations (Kennedy *et al.*, 1999; Anderson, 2000; Potter and Burney, 2002). Policy makers in parts of Europe and Asia fear that trade liberalisation and reduction of agricultural support may adversely affect the provision of public goods which are jointly produced with agricultural commodities (Hodge, 2000; Mahé, 2001; Latacz-Lohmann and Hodge, 2001). While these countries stress the importance of safeguarding the provision of public environmental goods, critics suspect that the multifunctionality argument is used as a pretext for protective domestic policy measures (Vasavada and Warmerdam, 1998; Freeman and Roberts, 1999; Bagwell and Staiger, 2001; Blandford *et al.*, 2003). The question of whether domestic support policies pursuing multifunctional goals can be classified as non-trade distorting has therefore become a controversial issue in the WTO process (Swinbank, 1999; Ervin, 1999; Josling, 2003).

Neoclassical trade theory suggests that world welfare is enhanced if (and only if) efficient environmental policies are introduced while trade is liberalised (Anderson, 1992; Runge, 1999). However, agri-environmental policy is still in its infancy. It was not until 1992 that the concept of paid stewardship was introduced into the EU's Common Agricultural Policy (CAP) (Latacz-Lohmann and Hodge, 2003). For decades, the CAP's commodity regimes had provided price support to European farmers without being accompanied by specific environmental policies addressing agriculture's multifunctional non-market effects. The virtual absence, until recently, of such policies may reflect the view held by many policy makers that previous levels of protection had resulted in an optimal supply of these benefits. The paucity of specific policy measures may also explain the critical attitude towards trade liberalisation among policy makers in parts of Asia and Europe: if an uncorrected distortion exists in one sector (*e.g.* non-internalised externalities), then the optimising rules for the remaining sectors (*e.g.* free trade) will generally no longer produce optimal resource allocation (Lipsey and Lancaster, 1956).

Since the conclusion of the GATT Uruguay Round Agreement on Agriculture (URAA) in 1994, which is often referred to as the initiation of trade liberalisation in the agricultural sector, agri-environmental policy has become increasingly important in the EU (Guyomard *et al.*, 1993; Josling and Tangermann, 1999). Other countries such as Japan, South Korea, Switzerland and Norway are likely to follow this route as international pressure for reform of their domestic farm support regimes is beginning to mount. Prior to the 2003 CAP reforms, agri-environmental payments had a less than 5 percent share of the total CAP budget (European Commission, 2003). However, as a result of the latest CAP reforms, a significant share of the budget currently spent on direct support measures is to be transferred, through modulation, to the rural development section of the CAP, from which the EU's agri-environmental policy is financed.

This paper aims at investigating the extent to which the increasing importance of agri-environmental policy may be attributed to tariff reduction requirements agreed in recent WTO trade negotiations. We formally demonstrate that tariff reduction requirements reinforce the incentive for a large country to introduce environmental policy. We show that the optimal environmental policy will be distorted to the extent that it partly substitutes for the tariff reduction. We further show how this policy change, *i.e.* trade liberalisation in conjunction with the introduction of a distorted environmental policy, affects global welfare. We demonstrate that, while global welfare effects of trade liberalisation are generally ambiguous in the absence of environmental policy, social welfare is unanimously enhanced if trade liberalisation in an importing country is accompanied by the introduction of environmental policy. This result even holds if environmental policies are strategically chosen to partly substitute for tariff reductions. Our analysis thus suggests that, although the multifunctionality argument may lend some support to the criticism of trade liberalisation, the argument is not solid when trade liberalisation induces the introduction of environmental policy.

The paper is organised into six further sections. The first section presents the model, the second one analyses the optimal tariff in the absence of environmental policy. This is taken to represent the situation prior to the GATT Uruguay Round when the CAP's commodity regimes provided price support to farmers without explicitly addressing the various positive and negative environmental externalities of agriculture. The third section then examines how tariff concessions affect a country's incentive to introduce environmental policy. In the two following ones, we analyse the welfare implications of trade liberalisation, depending on whether the country offering tariff concessions simultaneously introduces an optimal environmental policy or not. The last section revisits some of the critical assumptions underlying the analysis and explores how results would change if these were relaxed. The paper concludes with a summary of the main findings.

The model

The analysis is based on an extended version of Krutilla's (1991) partial equilibrium trade model, which considers a negative environmental externality linked to production. Krutilla demonstrated that a large importing country opening up to free trade would set its environmental output tax rate below the level of the Pigouvian tax rate. The rationale behind this is that a lower tax rate stimulates domestic production which improves the country's terms of trade. A strategically distorted environmental policy thereby acts as a substitute for an optimal tariff.

We are aware that a tax or subsidy linked to production does not represent agri-environmental policy particularly well. An alternative approach would have been to model environmental policy as a tax on environmentally harmful inputs in combination with a subsidy linked to land use, based on the framework presented by Peterson *et al.* (2002). While this would have provided a better characterisation of agri-environmental policy, it would have increased the complexity of the analysis to the point that no meaningful insights into the interactions of trade and environmental policies could have been gained. We have therefore chosen to build our model around Krutilla's (1991) framework which models environmental policy as a tax/subsidy linked to externality-generating outputs.

We extend Krutilla's (1991) *one*-country model by including a second large country. The two countries trade in a single homogeneous agricultural commodity. This extension allows us to analyse both domestic and *global* welfare effects. The supply in the home country (Country 1) is produced at cost $C_1(S_1)$, but production also affects the environment $E_1(S_1)$. We assume that the environmental impact of production ($\partial E_1(S_1)/\partial S_1$), which includes agriculture's multifunctional benefits, is not internalised into the market system and that externalities do not spill over across national boundaries. The analysis is based on the assumption that agriculture's positive non-market effects more than outweigh the detrimental impacts at all levels of production, that is, the net environmental effect is positive throughout. We further assume that the utility from marginal environmental improvements is decreasing. Hence, $\partial E_1(S_1)/\partial S_1 > 0$ and $\partial^2 E_1/\partial S_1{}^2 < 0$. We emphasize that the assertion of a positive net environmental impact is not necessarily true. Especially at high levels of agricultural output, the sign of the net effect may indeed be negative. However, we maintain the assumption of a positive net effect because this paper aims to test whether agriculture's multifunctionality provides a case against trade liberalisation based on the hypothesis of an overall positive environmental effect of farming. The last section provides a brief discussion of how results would change if agri-environmental externalities were negative.

The agricultural good is also produced in the foreign country (Country 2); however, in the interest of simplicity, the environmental impact of production abroad is assumed to be neutral. The government of the home country can fix a tariff, defined as a tax on imports *(T)* or subsidy on exports *(-T),* and implement agri-environmental policy. Abstracting from the complexity of a first-best policy design, we model agri-environmental policy as a tax (*t*) or subsidy (-*t*) linked to production, for the reasons set out above.

This is not to say, we emphasize, that we advocate production subsidies for the internalisation of multifunctional non-market effects. As explained above, the provision of environmental public goods is best addressed by a more targeted policy which addresses the problem at its source. However, given the difficulty of integrating such first-best policies into trade models, we revert to the compromise of modelling agri-environmental policy as a tax or subsidy on production, with tax/ subsidy rates reflecting the marginal social cost/value of the environmental impacts.

We assume that the tax/subsidy and tariff instruments are not available to the authorities abroad. That is, we do not allow for the possibility of direct or indirect retaliatory action taken by the foreign country. 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 $D_2(P_w)$ schedules 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 $\partial^2 S_1/\partial P_{S_1}{}^2, \partial^2 S_2/\partial P_w{}^2 \le 0$, $\partial^2 D_1/\partial P_{D_1}{}^2, \partial^2 D_2/\partial P_w{}^2 \ge 0$. Building upon these relationships, social welfare functions can be defined for both the home country and the foreign country. Country 1's welfare (W_1) is defined as the sum of consumer surplus and producer benefit, tax revenues, tariff revenues, and the value of the environmental externality [1]:

$$W_1(t,T) = \int_{P_{D_1}}^{\infty} D_1(P_{D_1})\, dP_{D_1} + P_{S_1} S_1(P_{S_1}) - C_1(S_1(P_{S_1})) + t\, S_1(P_{S_1})$$
$$+ T\left[D_1(P_{D_1}) - S_1(P_{S_1})\right] + E_1(S_1(P_{S_1})) \tag{1}$$

Analogously, equation (2) defines social welfare for Country 2 (W_2) as the aggregate of consumer surplus and producer benefit:

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

We assume that world welfare can be depicted as the sum of welfare of the home and foreign country ($W = W_1 + W_2$). Furthermore, the model is based on the trade equilibrium requirements of excess demand ($-X_i = D_i - S_i$) in Country 1 being equal to excess supply in Country 2:

$$X_1 = -X_2 \tag{3}$$

In the interest of simplicity, we ignore the existence of transaction and transportation costs. Hence, the margin between the home country's demand price P_{D_1} and the world price P_w is determined solely by the tariff rate, while the environmental tax/subsidy rate exclusively determines the difference between domestic supply price P_{S_1} and demand price. The model is completed with the assumption of perfect competition, hence supply prices equal marginal production costs both at home and abroad:

$$P_w = \partial C_2 / \partial S_2 = P_{D_1} - T \qquad\qquad P_{S_1} = \partial C_1 / \partial S_1 = P_{D_1} - t \tag{4}$$

The optimal tariff rate prior to trade liberalisation

We begin by deriving the optimal tariff rate prior to trade liberalisation as a benchmark for the subsequent analysis. Assume that Country 1 is free to set its environmental tax/subsidy and tariff rates simultaneously in order to maximise domestic welfare. The first-order conditions for an interior maximum are obtained by

[1] 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.

taking the partial derivatives of (1) with respect to the tax/subsidy 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 equation (3) and (4) to simplify the result, we obtain:

$$\frac{\partial W_1}{\partial t} = \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{(\alpha+\beta)} \left(X_1 - \left(\frac{\partial E_1}{\partial S_1} + t \right) \left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta \right) + T\beta \right) = 0 \tag{5}$$

$$\frac{\partial W_1}{\partial T} = \frac{1}{(\alpha+\beta)} \left(-X_1\alpha + \left(t + \frac{\partial E_1}{\partial S_1} \right) \frac{\partial S_1}{\partial P_{S_1}} \beta - T\alpha\beta \right) = 0 \tag{6}$$

where $\alpha = \partial S_1/\partial P_{S_1} - \partial D_1/\partial P_{D_1}$

and $\beta = \partial S_2/\partial P_w - \partial D_2/\partial P_w$

Simultaneously solving equations (5) and (6) yields:

$$t_1^{**} = -\frac{\partial E_1}{\partial S_1} \quad \text{and} \quad T_1^{**} = -X_1/\beta \tag{7}$$

Equation (7) constitutes the first-best policy set for a country aiming to maximise domestic welfare. The first-best environmental policy t_1^{**} is the Pigouvian tax/subsidy rate ($-\partial E_1/\partial S_1$), while the first-best tariff T_1^{**} 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 Country 2's excess supply (β).

These findings are contrary to actual policy observations. We argued above that agri-environmental policy had, for a long time, been virtually non-existent in countries stressing the importance of agriculture's multifunctionality. Besides reasons of government failure, efficient agri-environmental policies may not have been implemented because of prohibitively high administrative costs or information deficiencies, or simply because previous levels of protection were deemed appropriate for generating a sufficient supply of multifunctional benefits. This is not the place to speculate about the political reasons for the paucity of agri-environmental policy. We conclude that the first-best policy set in (7) is apparently not the correct benchmark for the subsequent analysis if governments, for whatever reason, do not make appropriate use of the environmental policy instrument. A more appropriate benchmark seems to be one that assumes maximisation of domestic welfare by choosing T, while t is fixed at some arbitrary level, say $t = 0$. We term the resultant level of T the second-best tariff policy, *i.e.* the tariff rate that maximises domestic welfare in the absence of environmental policy ($t^o = 0$). This tariff rate T_1^* is computed by solving equation (6) for the tariff rate [2]:

$$T_1^*(t) = -\frac{X_1}{\beta} + \left(t + \frac{\partial E_1}{\partial S_1} \right) \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{\alpha} \tag{8}$$

Equation (8) demonstrates that the optimal tariff in the absence of environmental policy is unambiguously positive ($T_1^*(t^o) > 0$) for an importing country ($X_1 < 0$), and that it deviates from the first-best tariff in (7) to the extent that it has to correct for the missing environmental policy. Although the second-best policy in (8) is inferior to the first-best policy set of equation (7), it will be chosen as the benchmark for the subsequent analysis, since it may better reflect the political reality of most countries prior to conclusion of the URAA.

Do tariff reduction requirements encourage environmental policy?

We now proceed to analyse whether tariff reduction requirements create a distinct incentive for a country to introduce environmental policy. As stressed above, we conduct this analysis against the benchmark of a second-best tariff as per (8) in the absence of environmental policy. To assess the incentive for introducing environmental policy, we analyse the home country's welfare functions, depending on whether an optimal environmental policy is implemented ($W_1(t_1^*)$) or not ($W_1(t^o)$) [3].

We begin by analysing how domestic welfare is affected if Country 1 introduces an optimal environmental policy while the tariff remains at the second-best level as per (8). It is generally plausible that Country 1's welfare will increase if it adjusts its environmental policy, hence $W_1(t_1^*(T),T) \geq W_1(t^o,T)$ [4]. Furthermore, we can demonstrate that, for a net-importing country, the domestically optimal second-best tariff rate in the absence of environmental policy is generally higher than the first-best tariff rate, as depicted in Figure 1. This conclusion is derived as follows: by substituting equation (8) into (5), we can analyse how domestic welfare in the benchmark scenario is affected by a marginal change of the tax/subsidy rate:

$$\frac{\partial W_1(t^o, T_1^*(t^o))}{\partial t} = \frac{\partial D_1}{\partial P_{D_1}} \frac{\partial E_1}{\partial S_1} \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{\alpha} \tag{9}$$

The derivative in (9) assumes a negative value as t is marginally increased, suggesting that the domestically optimal environmental policy in the benchmark scenario is a subsidy (negative tax). Implementing an environmental subsidy, in turn,

[2] Note, that the domestically optimal tariff T_1^* deviates from the tariff calculated within Krutilla's (1991) partial equilibrium framework, which was not correctly specified.

[3] Let t_1^* denote the domestically optimal second-best tax/subsidy rate for a given tariff rate.

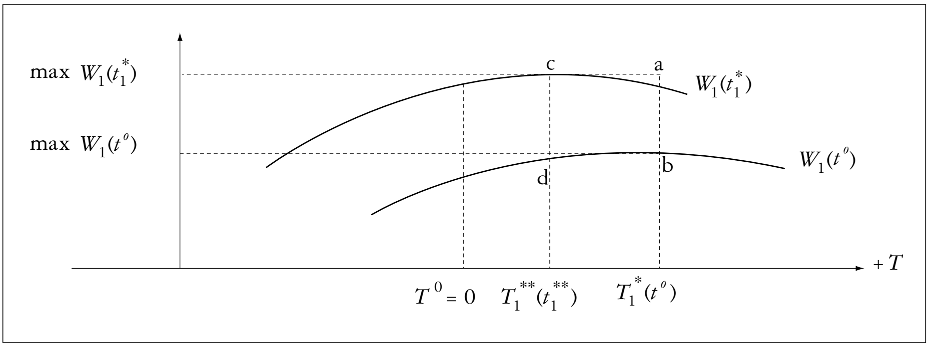
[4] Domestic welfare with and without environmental policy will be equal to the tariff rate at which the optimal second-best tax/subsidy rate is zero ($t_1^* = 0$). For any other tariff rate, domestic welfare will increase as a result of introducing a domestically optimal environmental policy.

lowers Country 1's optimal tariff rate. This can be shown by taking the first derivative of equation (8) with respect to the environmental tax rate:

$$\frac{\partial T_1^*(t^o)}{\partial t}=\frac{X_1}{\beta^2}\frac{\partial \beta}{\partial t}-\frac{\partial X_1}{\partial t}\frac{1}{\beta}+\frac{\partial E_1}{\partial S_1}\frac{1}{\alpha^2(\alpha+\beta)}\left(\frac{\partial D_1}{\partial P_{D_1}}\frac{\partial^2 S_1}{\partial P_{S_1}{}^2}\left(-\frac{\partial D_1}{\partial P_{D_1}}+\beta\right)+\frac{\partial S_1}{\partial P_{S_1}}\frac{\partial S_1}{\partial P_{S_1}}\frac{\partial^2 D_1}{\partial P_{D_1}{}^2}\right)+\left(1+\frac{\partial^2 E_1}{\partial S_1{}^2}\frac{\partial S_1}{\partial t}\right)\frac{\partial S_1}{\partial P_{S_1}}\frac{1}{\alpha} \qquad (10)$$

Equation (10) assumes a positive value for a large net-importing country, proving that the first-best tariff is lower than the second-best tariff: $(T_1^{**}(t_1^{**})<T_1^*(t^o))$. This relationship is illustrated in Figure 1.

Figure 1. **Domestic welfare functions for a large net-importing country (X_1 < 0) with and without environmental policy**



Based on the constellation of the domestic welfare functions with and without optimal environmental policy, as illustrated in Figure 1, we can now demonstrate that the incentive for a large net-importing country to introduce environmental policy increases as the tariff is reduced. This can be seen by considering the move from point *b* to point *c* in Figure 1. Point *b* represents the country's initial welfare level - prior to tariff reduction requirements in the absence of environmental policy, when the country operates a second-best tariff $T_1^*(t^o)$ which partly substitutes for the lack of environmental policy. If Country 1 now were to introduce an environmental subsidy to internalise the multifunctional non-market benefits, it would deliberately reduce the tariff rate from $T_1^*(t^o)$ to $T_1^{**}(t_1^{**})$, thus achieving welfare level *c* in Figure 1. The potential welfare gain associated with the initiation of the optimal environmental policy in the benchmark scenario is thus given by distance $\overline{ab}$.

We now proceed to assess the potential welfare gain from implementing an environmental policy if an international trade agreement requires the home country to lower its tariff rate, say, from $T_1^*(t^o)$ to $T_1^{**}(t_1^{**})$ in Figure 1. At tariff rate $T_1^{**}(t_1^{**})$, Country 1 can only attain welfare level *d* in the absence of environmental policy.

However, with the domestically optimal environmental subsidy rate in place, it could reach welfare level c; the gain in domestic welfare thus equals $\overline{cd}$. Since the welfare gain from introducing environmental policy increases from $\overline{ab}$ (without tariff reduction requirement) to $\overline{cd}$ (with tariff reduction requirement), we conclude that tariff concessions reinforce the incentive for a country to introduce environmental policy, *quod erat demonstrandum*. Note that this incentive becomes even stronger as the tariff is reduced below $T_1^{**}(t_1^{**})$, since the gap between the two welfare functions increases.

Welfare effects of trade liberalisation in the absence of environmental policy

Having demonstrated that trade concessions encourage environmental policy, the question now is how this policy change affects *global* welfare. Before turning to this question in the following section, we first analyse the welfare implications of trade liberalisation in the absence of environmental policy, since this may explain the criticism of free trade voiced in the multifunctionality debate.

In order to assess the global welfare effects of tariff reductions in the absence of environmental policy, we derive as a benchmark the policy set that maximises *world* welfare. We shall refer to the latter as the *globally* (as opposed to the *domestically*) optimal policy set. The globally optimal first-best policy solution for an open economy is free trade ($T_w^{**}=0$) combined with a Pigouvian tax or subsidy ($t_w^{**}=-\partial E_1/\partial S_1$). This result can be formally established by setting the partial derivatives of the world welfare function ($W=W_1+W_2$) equal to zero. Applying the constraints in equations (3) and (4) to simplify the result, we obtain:

$$\frac{\partial W}{\partial t}=\frac{\partial S_1}{\partial P_{S_1}}\frac{1}{(\alpha+\beta)}\left(\left(t+\frac{\partial E_1}{\partial S_1}\right)\left(\frac{\partial D_1}{\partial P_{D_1}}-\beta\right)+\beta T\right)=0 \tag{11}$$

$$\frac{\partial W}{\partial T}=\frac{1}{(\alpha+\beta)}\left(\left(t+\frac{\partial E_1}{\partial S_1}\right)\frac{\partial S_1}{\partial P_{S_1}}\beta-\alpha\beta T\right)=0 \tag{12}$$

Solving equations (11) and (12) simultaneously for the tax and tariff rates yields:

$$t_w^{**}=-\partial E_1/\partial S_1 \qquad \text{and} \qquad T_w^{**}=0 \tag{13}$$

However, in the absence of environmental policy (or, more generally, if the tax/subsidy rate is not set at the Pigouvian level), free trade is no longer the first-best solution. By solving equation (12) for the tariff rate, we obtain the globally optimal *second*-best tariff rate as follows:

$$T_w^{*}=\left(t+\frac{\partial E_1}{\partial S_1}\right)\frac{\partial S_1}{\partial P_{S_1}}\frac{1}{\alpha} \tag{14}$$

It is clear from (14) that, for a net-importing country, a positive tariff is the globally optimal trade policy in the absence of environmental policy. This is plausible because the tariff would increase domestic production, thereby stimulating the supply of environmental benefits associated with production [5]. From this we conclude that full trade liberalisation is not efficient if environmental externalities are not internalised through appropriate policies.

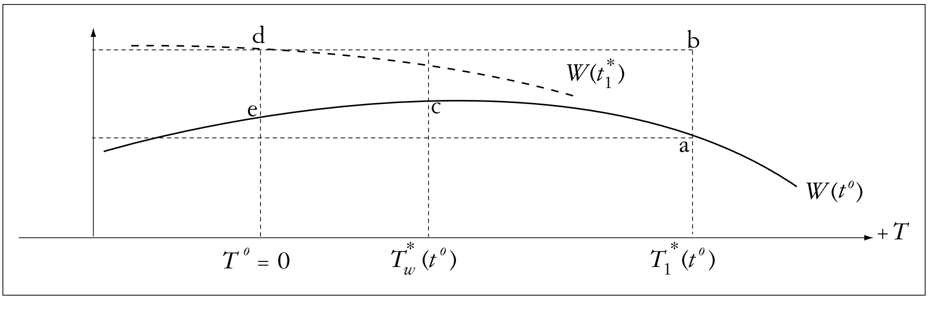
Next we demonstrate that, in the absence of environmental policy, the domestically optimal second-best tariff is higher than the globally optimal tariff ($T_1^*(t^o) > T_w^*(t^o)$). This can be proven by evaluating the marginal global welfare change (equation (12)) at the domestically optimal second-best tariff rate of equation (8):

$$\frac{\partial W(t^o, T_1^*(t^o))}{\partial T} = \frac{\alpha}{(\alpha+\beta)} X_1(t^o, T_1^*(t^o)) \tag{15}$$

Since equation (15) assumes a negative value for a net-importing country, we infer that lowering a domestically optimal tariff increases world welfare. The rationale behind this is that a net-importing country's optimal trade policy not only corrects for the missing environmental policy, but also improves its terms of trade through the fact that the domestically optimal tariff rate is higher than the globally optimal one.

These relationships are illustrated in Figure 2. In the absence of environmental policy, global welfare is maximised at a positive tariff rate ($T_w^*(t^o) > 0$), yielding welfare level *c*. The figure also depicts free trade ($T^o = 0$) as well as the domestically optimal second-best tariff $T_1^*(t^o)$ which was shown to be higher than the globally optimal tariff ($T_w^*(t^o)$), with the corresponding welfare levels *e* (for free trade) and *a* (for the second-best tariff). From this we conclude that, in the absence of efficient environmental policy, a partial move towards free trade (move from *a* to *c*) will enhance global welfare, whereas the sign of the global welfare effect of full trade liberalisation (move from *a* to *e*) remains ambiguous.

Figure 2. **World welfare functions for alternative trade/environmental policy combinations in a net-importing country**



5 Note that this conclusion is sensitive to the strong jointness assumption, whereby the supply of multifunctional benefits is a strictly increasing function of domestic agricultural production (represented by the domestic supply of the single agricultural commodity).

Welfare effects of trade liberalisation and environmental policy

We now turn to the case of Country 1 launching an environmental policy programme in response to tariff reduction requirements. The domestically optimal environmental policy for any given tariff rate (including free trade) is derived by solving equation (5) for the tax/subsidy rate:

$$t_1^*(T) = -\frac{\partial E_1}{\partial S_1} + (X_1 + T\beta)\left(-\frac{\partial D_1}{\partial P_{D_1}} + \beta\right)^{-1} \tag{16}$$

The domestically optimal tax/subsidy rate internalises the environmental externality, represented by the first term of equation (16). It further includes a "strategic" component, indicated by the second term of equation (16). The strategic component can be interpreted as a substitute for the optimal tariff. It is clear from (16) that the strategic component is zero for a small country, implying that the Pigouvian tax/subsidy scheme is the optimal policy choice. For a large country, however, the environmental policy deviates from the Pigouvian tax/subsidy rate to the extent that it substitutes for the tariff.

We now demonstrate that abolition of a positive tariff in a large importing country, combined with the launch of an optimal environmental policy (move from *a* to *d* in Figure 2) will unambiguously enhance global welfare. This result is obtained in two steps. We first derive the domestically optimal environmental policy response at the globally optimal second-best tariff rate:

$$\frac{\partial W_1(t^o, T_w^*(t^o))}{\partial t} = \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{(\alpha+\beta)}\left(X_1 + \frac{\partial D_1}{\partial P_{D_1}} \frac{\partial E_1}{\partial S_1} \frac{1}{\alpha}(\alpha+\beta)\right) \tag{17}$$

Since equation (17) takes a negative value for a net-importing country, the domestically optimal environmental policy response is an environmental subsidy. Next, we analyse how global welfare is affected by that environmental subsidy:

$$\frac{\partial W(t^o, T_w^*(t^o))}{\partial t} = \frac{\partial E_1}{\partial S_1} \frac{\partial S_1}{\partial P_{S_1}} \frac{1}{\alpha} \frac{\partial D_1}{\partial P_{D_1}} \tag{18}$$

Since equation (18) assumes a negative value, we conclude that global welfare increases if the home country introduces an environmental subsidy while maintaining the globally optimal second-best tariff rate $(W(t_1^*, T_w^*(t^o)) > W(t^o, T_w^*(t^o))$. This is illustrated in Figure 2. We can now show that, once a domestically optimal environmental policy has been introduced, abolishing the tariff further enhances global welfare. This result is formally established by determining the globally optimal tariff rate for the home country's domestically optimal environmental policy. The latter is obtained by inserting equation (16) into (14) and solving for the globally optimal tariff rate:

$$T_w^{**}(t_1^*(T_w^{**})) = -\frac{X_1}{(\alpha+\beta)} \frac{\partial S_1}{\partial P_{S_1}} \left(\frac{\partial D_1}{\partial P_{D_1}}\right)^{-1} \tag{19}$$

Since equation (19) takes a negative value for a net-importing country, we conclude that, in the presence of a strategically chosen environmental policy, global welfare ($W(t_1^*)$) is maximised at a negative tariff rate. This is plausible because the tariff would need to correct for the distorted environmental policy (Figure 2). By making use of equations (12), (16) and (19), it can be proven that the slope of the global welfare function is generally negative ($\partial W / \partial T < 0$) for any $T > T_w^*(t_1^*(T_w^*))$. This provides the proof that global welfare increases unambiguously (by $\overline{ab}$ in Figure 2), if the abolition of a positive tariff is accompanied by the introduction of a strategically distorted environmental policy.

In sum, we can conclude from the analysis that in the absence of environmental policy, full trade liberalisation does not maximise global welfare. If, however, trade liberalisation induces a country to implement environmental policy, full trade liberalisation is the globally optimal solution, even if the environmental policy is chosen to partly substitute for the tariff.

Discussion

The analysis in this paper is based on a number of critical assumptions and simplifications, most of which were necessary to facilitate the modelling of the interaction between trade and environmental policies. The question therefore arises whether the findings and conclusions from the analysis still hold under more general assumptions.

The most critical simplification relates to the modelling of agri-environmental policy as a tax/subsidy linked to agricultural output (Krutilla, 1991) as opposed to agricultural inputs (Peterson *et al.,* 2002). We argued that the more elaborate input-based representation of agri-environmental policy would have made the analysis intractable. We have used the simple specification to demonstrate, among other things, that global welfare is unambiguously enhanced if trade concessions induce an environmental policy programme which did not exist previously. This principle holds regardless of whether environmental policy is modelled as an input-based or an output-based tax/subsidy, provided that environmental amenities are (at least to some extent) produced jointly with agricultural commodities. In both cases, an optimal environmental policy is distorted to the extent that it stimulates domestic production, thereby influencing the world price in the home country's favour. Modelling environmental policy as a tax/subsidy linked to output represents an upper limit on the output effect caused by a domestically optimal environmental policy. A more targeted policy would achieve environmental enhancements with less output distortion. We have demonstrated that an output-based environmental policy unambiguously enhances global welfare, that is, the welfare loss due to the indirect distortions is more than outweighed by the welfare gains from trade liberalisation. This effect will be more pronounced for a more targeted environmental policy that addresses the use of inputs rather than outputs.

Another assumption relates to retaliation. The two-country model with a single commodity does not allow for retaliation by the foreign country, especially since the tax/subsidy and tariff instruments are assumed unavailable to the government of the foreign country. Based on this simple model, the exploitation of terms-of-trade effects via domestic environmental policy was shown to be unambiguously welfare-enhancing for the home country. This conclusion may change if the possibility of retaliatory action were included in the model: The welfare-enhancing effect would be much reduced, if not eliminated, in a multi-commodity world where countries are exporters of some goods and importers of others. Exploring the impact of retaliation, however, would have required a game theoretic approach to modelling trade-environment interactions. We leave this topic for future work.

The analysis is predicated on the assumption that agriculture's positive non-market effects more than outweigh the detrimental impacts at all levels of production. This assumption, though controversial, was driven by the objective to test whether agriculture's multifunctionality provides a case against trade liberalisation based on the hypothesis of an overall positive environmental effect of farming. The model is general enough to enable analysis of a net *negative* effect of the form $\partial E_1(S_1)/\partial S_1 < 0$. For a large net-importing country, with a negative overall environmental impact of agriculture:

– the first-best environmental tax rate t_1^{**} is the Pigouvian tax (as per equation (7));

– the domestically optimal tax rate is lower than the Pigouvian tax rate so as to stimulate domestic production, thereby influencing the world price in the home country's favour (as per equation (16));

– in the absence of an environmental tax programme, full trade liberalisation does not result in maximum world welfare, and a negative tariff which discourages domestic production and thus negative externalities is the optimal policy choice (see equation (14));

– global welfare is unambiguously enhanced if tariff reductions induce the domestically optimal (distorted) environmental tax programme.

Another simplifying assumption relates to the environmental impact of agricultural production in the foreign country. This was assumed to be neutral. Some of the key conclusions from the analysis are likely to change if we had allowed for non-neutral environmental impacts abroad. It is far from clear then whether trade liberalisation in conjunction with the introduction of a distorted environmental policy programme would enhance global welfare. We can only speculate about the sign of the global welfare effect because we are considering the movement from one second-best situation (*i.e.* tariff without environmental policy) to another (free trade with distorted environmental policy and non-internalised externalities abroad). However, all conclusions would remain unchanged if one assumed that the environmental externalities in the foreign country were efficiently internalised through appropriate environmental policy.

Another aspect worth exploring is linkages to other sectors and commodities. The simple one-commodity setup of the model was appropriate to understand the principles underlying the interaction between trade and environmental policies, which was the key objective of the paper. Exploring the linkages between agriculture and other sectors, or among multiple agricultural commodities, would have required the application of a computable general equilibrium model. For the latter, the reader is referred to the relevant literature (*e.g.* Cretegny, 2002). Comparisons between partial and general equilibrium models of agricultural trade liberalisation have demonstrated that welfare changes will differ in scale. However, they are unlikely to differ in sign (Bautista *et al.,* 2001 ; Gohin and Moschini, 2006).

Conclusion

In this paper we extended Krutilla's (1991) trade model to investigate whether multifunctionality provides a sound rationale for maintaining trade barriers. We conducted our analysis against the benchmark of agricultural policies that prevailed before the conclusion of the URAA, when many net-importing countries had in place tariff policies which partly substituted for specific environmental policies addressing agriculture's multifunctionality. We first demonstrated that tariff reduction requirements provide an extra incentive for a large net-importing country to introduce an environmental policy programme. We then analysed the global welfare effects of trade liberalisation, with and without simultaneous introduction of environmental policy.

If no environmental policy is implemented, full trade liberalisation does not result in maximum world welfare. The *globally* optimal trade policy for a net-importing country remains a positive tariff, which partly substitutes for the missing environmental policy. If, however, trade concessions are accompanied by the implementation of an environmental policy programme, the domestically optimal environmental policy deviates from the Pigouvian solution. If a country is sufficiently large to manipulate its terms of trade, the environmental policy programme partly substitutes for an optimal tariff policy. Notwithstanding this deviation, global welfare will be unambiguously enhanced as long as trade liberalisation induces an environmental policy programme which did not previously exist. This principle holds regardless of whether environmental policy targets the use of inputs (Peterson *et al.*, 2002) or the use of outputs (Krutilla, 1991), provided that environmental amenities are (at least to some extent) produced jointly with agricultural commodities.

Returning to the key motivating question of this paper, we conclude that multifunctionality cannot provide a sound rationale for maintaining trade barriers, except when there is little prospect for the introduction of environmental policy in response to trade liberalisation. Only in such circumstances may the multifunctional role of agriculture provide a case against full trade liberalisation. A positive tariff would then serve to mimic the role of environmental policy. The recent CAP reforms, however, have provided ample evidence that the move towards more liberal agricultural trade does have an influence on the design of domestic policies, and that agri-environmental policies in particular could be responsive to changes in the level of protection. The increasing importance of agri-environmental contracting, the linking of environmental cross-compliance conditions to the EU's single payment scheme, and the introduction of 'modulation' have demonstrated that tariff reduction requirements may constitute a supplementary argument which reinforces the incentive for the introduction of agri-environmental policies. The analysis in this paper suggests that, as long as domestic policy is responsive to reduced levels of protection, full trade liberalisation is the globally optimal solution, even if domestic environmental policies are designed to partly substitute for border protection. We thus conclude that, in the current EU policy environment, the multifunctional role of agriculture does not provide a valid rationale for obstructing the way towards freer trade in agricultural commodities.

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