Assessing the agricultural trade and environment interaction: Taking stock and looking ahead

Thilo W. Glebe

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Abstract

This paper reviews the literature on the interface of trade liberalisation, the environment and environmental policies in the context of the agricultural sector. The theoretical literature has been ambiguous concerning the sign of the net welfare effect of trade liberalisation if externalities are present, and empirical studies have not been able to resolve this ambiguity. Analyses of environmental policies, on the other hand, have focused on identifying optimal environmental measures to maximise domestic welfare, but have neglected the impact of environmental policies on global welfare. The paucity of a theoretical framework for the global welfare analysis of agricultural trade and environmental policies constrains the ability to classify agri-environmental or agricultural trade policies as trade-neutral, trade-distorting or trade-correcting.
1 Introduction

The Uruguay Round Agreement on Agriculture in 1993 is often interpreted as a first step towards freer agricultural trade which may provide a basis for further reforms in future trade rounds (Guyomard et al. 1993; Josling and Tangermann 1999). However, there seems to be no consensus among the major trading partners as to whether the world should move on to further trade liberalisation. An important argument opposing free agricultural trade is related to its impact on the environment. As trade liberalisation would affect the level of agricultural output, this would cause global adjustments in land, fertiliser and pesticide use for farming. A change in the use of agro-chemical inputs will have an impact on groundwater quality, the atmosphere, soil erosion and biodiversity. In particular, it is claimed by critics that land use changes may adversely influence the cultural landscape. There is also a widespread concern that trade liberalisation may lead to the conversion of forests to agricultural uses in countries where forests are treated as unregulated common property.

The mainstream neo-classical counter-argument to such criticisms is that international trade is not the source of environmental problems, which are rather due to various forms of market and government failures. If the prices of environmental resources reflected the true social value, international trade would allocate resources according to the principles of comparative advantage and lead to the production of an optimal set of final goods and services. If trade liberalisation is blamed for causing an inefficient use of environmental resources, then it is because those environmental resources were not correctly priced; resource misallocation would occur irrespective of international trade.

However, agricultural externalities are difficult to internalise into market mechanisms, due to various technical and administrative constraints. If environmental policies are sub-optimal and first-best policy solutions are far from being achieved, free trade may not necessarily enhance social welfare. In fact, trade liberalisation itself may lead to sub-optimal environmental policies. This will happen if environmental policy instruments are used by nation states as an excuse to further a protectionist trade agenda or to manipulate terms of trade in their favour.

The economically appropriate benchmark against which the trade distorting character of agricultural policies can be judged would be the impact they have on global welfare. The objective of this paper is therefore to analyse the extent to which the global welfare effects of trade and environmental policies have been assessed in the literature. Furthermore, the paper
will review the conceptual frameworks with regard to their appropriateness for the analysis of
the trade and environment nexus in the agricultural sector.

The paper is organised as follows. The following section reviews the environmental and
welfare implications of agricultural trade liberalisation by dividing the literature into
theoretical, empirical and computable general equilibrium approaches. Section 3 surveys the
literature on the trade and welfare implications of environmental policies.

2 Environmental and welfare implications of agricultural trade liberalisation

2.1 Conceptual analyses

The welfare analysis of agricultural trade policies would need to account for the specific
characteristics of environmental externalities associated with agricultural production.
However, the nature of agri-environmental effects is highly complex and location-specific,
since it depends on natural conditions like soil, climate and ecosystem. It varies also with
different management practices related to cropping patterns, land preparation, irrigation, use
of livestock wastes and agro-chemicals. Given the high complexity of the interaction between
agricultural production and its environmental impact, conceptual approaches used in the
literature on agricultural trade and the environment have been rather simple. In fact, the
common approach has been to express agri-environmental externalities as a simple function
of agricultural output.

If environmental effects are defined as a function of output, the analysis of agricultural trade
liberalisation will not significantly differ from those of many non-agricultural sectors. This
may explain why most studies analysing the trade and environment interaction within the
discipline of agricultural economics are built on a rather general conceptual framework.
Hence, a discussion of the suitability of theoretical models applied to the welfare analysis of
agricultural trade and the environment will in turn also refer to approaches chosen in the
economic core literature and not be restricted to the agricultural economic literature.

The impact of trade liberalisation in the presence of environmental externalities has only
recently been investigated by the academic community. Baumol and Oates (1988) and Snape
(1992) used a simple diagrammatic trade model to analyse domestically optimal tariff rates if
production is associated with trans-border pollution. Baumol and Oates (1988) assumed that a
victim nation affected by emissions originating in another country had sufficient market
power to influence the world price through its tariffs. If imports generated costs that were external to an exporting country, there would exist a second-best tariff for the importing country. However, this would not necessarily be the one that yielded an optimal allocation of resources for the world as a whole. Baumol and Oates (1988) showed that the tariff that maximised the importing nation’s net gain, in the presence of external costs imposed by the imports, would be higher than one that did so in the absence of externalities. If a trans-frontier externality fell entirely on the importing country, the tariff which maximised the importing country’s total gain from exploitation of its market power would be greater than the tariff maximising the aggregated welfare of both countries. However, even such a globally optimal tariff would only sustain a second-best solution, not the optimum that could be achieved by a set of internationally optimal Pigou taxes in the country where the externality was generated.

Snape (1992) used a simple partial equilibrium model to show that an importing country that is adversely affected by pollution originating in another country has a primary rather than a retaliatory reason to tax those imports which cause pollution. The exporting country producing the product, but not being polluted itself, could introduce an export tax to minimise pollution for the importing country and to receive tax revenues. However, the exporting country only has a primary incentive to tax exports if the other party, or an international authority levies taxes if it fails do so itself. The exporting country would be better off without either an import or an export tax. Snape (1992) argued that in the absence of international agreements with effective compliance, trade measures against imports can be justified to increase national and world welfare.

Both Baumol and Oates (1988) and Snape (1992) have analysed trans-border pollution, which is relevant in countries where the unregulated conversion of natural forests into agricultural land may lead to global warming. Trans-border emissions may also arise due to excessive fertiliser applications under circumstances in which this leads to denitrification of nitrogen. However, the majority of agri-environmental problems in most countries are of a domestic nature. An analysis of externalities confined to national boundaries, as conducted by Anderson (1992a; 1992b), seems thus to be a more suitable framework for analysing the welfare impact of agricultural trade policies.

Anderson (1992a; 1992b) has formulated a partial equilibrium model to show diagrammatically how the trade policies of one country might affect its own and the rest of the world’s social welfare. Social welfare changes were evaluated by using consumer and producer surplus measures and changes in tax and tariff revenue. Anderson (1992a; 1992b)
distinguished between the case of a small and a large country, between negative production and consumption externalities, and between exporting and importing countries. He demonstrated that if externalities are not internalised, liberalising trade in a good whose production (consumption) is pollution-intensive will improve a small country’s welfare if, following liberalisation, it imports (exports) this good; but if the good is exported (imported), the welfare effects will be ambiguous. In the case of a large country facing negative externalities, the welfare would increase for both the importing home country and its exporting trading partners after opening up to trade. The net welfare effects for a large exporting country liberalising trade and facing a negative externality would be ambiguous. This is because higher domestic prices after liberalisation would lead to gains in producer surplus, but also to an increase in external environmental costs and a loss of consumer surplus which, on balance, could be positive or negative. Sinner (1994) and Runge (1995) built upon Anderson’s partial equilibrium trade model and came to similar conclusions for the small country case.

Ito (1996) considered a large country opening up to trade within Anderson’s (1992a; 1992b) diagrammatic partial equilibrium framework. He demonstrated that agricultural trade liberalisation would only reduce external environmental costs if agriculture exerted more adverse effects on the environment in importing countries than in exporting countries. If the agricultural sector of an importing country had a beneficial effect on the environment, trade liberalisation would cause deterioration in the environmental quality of the world as a whole, because less positive environmental goods would be produced in the importing country, but negative external costs would increase in the exporting country. Furthermore, Ito (1996) concluded that within the framework of the vertical structure of world trade, where developed countries import agricultural commodities from developing countries, trade liberalisation may widen the income gap between the rich and the poor countries. This is because although exporting countries would benefit from better terms of trade after trade liberalisation, higher world prices would increase environmental pollution, which may outweigh the gains from trade.

Steininger (1994) extended Anderson’s (1992a; 1992b) one-good partial equilibrium model by introducing a second sector to his model. He showed graphically that in a two-commodity, two-country world with the existence of domestic production externalities, the aggregated net environmental effect of trade liberalisation would, in general, be ambiguous. Also the net welfare effect would crucially depend on the relative slope of supply and demand curves and the relative size of environmental externalities in both countries.
Copeland (1994) also used a general equilibrium model to investigate the conditions for welfare-improving policy reforms in a small open economy facing many trade and pollution distortions. He modelled pollution as a by-product of goods production and considered quotas and mixed regimes in addition to taxes. An important result of his algebraic analysis is that if trade and all pollutants are constrained by quotas, then any reduction of such market distortion will improve welfare. In a tax regime, in contrast, changing tax rates to reduce the occurrence of one pollutant may have the undesirable side effect of increasing emissions of other pollutants, or of shifting trade flows further away from their first-best level. Copeland (1994) also proved that the welfare improvement of reforming pollution policy is greater in an economy with factor mobility than in one without such mobility. This is because higher factor mobility increases the elasticity of the supply response and thus enhances the effectiveness of a tax change aiming to reduce pollution.

Copeland and Taylor (1999) have analysed the impact of free international trade assuming that the production of one sector generates pollution that lowers the productivity of another sector. They constructed a general equilibrium model consisting of a polluting manufacturing sector and an environmentally sensitive sector such as agriculture whose productivity is affected by the former. The authors demonstrated algebraically that free trade encourages the international specialisation of production processes and thereby encourages the spatial concentration of industries with increasing returns to scale. This may play a useful role in allowing incompatible industries to move away from each other and thus reduce the damage from cross-sectoral production externalities.

In summary, the focus of these conceptual analyses has been to analyse the net welfare effects of trade liberalisation at a domestic rather than a global level. A common finding has been that the sign of welfare changes for countries opening up to trade is highly case specific and mostly ambiguous. In terms of methodologies, two main types of conceptual approach to the analysis of the trade and environment interaction in the agricultural sector can be distinguished. The most commonly used approach, initially introduced by Anderson (1992a; 1992b), has been to analyse welfare changes within a simple, standard textbook, diagrammatic market diagram. An alternative approach, chosen by Copeland (1994), has been based on the utility functions of consumers and the aggregate revenue function of the economy. Copeland’s model has the advantage that marginal rather than absolute welfare changes can be calculated algebraically as a function of varying trade policies. But, it is designed to assess domestic welfare effects within a small country, rather than global welfare changes induced by a large country opening up to trade.
2.2 Empirical analyses

Empirical studies analysing the interaction of trade policies and the environment in the agricultural sector are often based on conventional empirical trade models in conjunction with separately estimated relationships between production activities and environmental outcomes. Anderson (1992a; 1992c) has built upon the results of a study undertaken by Anderson and Tyres (1991) and discussed the impact of agricultural trade liberalisation on the environment. He argued that free trade would not only generate large global welfare gains, it would also lead to a reduction of global environmental damage from farming and chemical residues in food.

Anderson (1992a; 1992c) distinguished between industrial countries whose farmers are assisted by price support policies, and developing countries whose governments keep food prices below international levels. The partial equilibrium simulation model used by Anderson and Tyres (1991) suggested that a move towards free agricultural trade would reduce relative prices in rich nations, but raise prices in poor nations, and would thus lead to an international relocation of crop production from rich to poor countries. Grain production would substantially decline in Western Europe and North America and increase particularly in Latin America. When applying certain estimated relationships between production activities and the use of chemicals, Anderson came to the conclusion that the overall use of chemicals in world food production would decline.

However, Anderson’s (1992a; 1992c) wider conclusion that free trade would increase environmental quality in industrial countries was based on a rather arbitrary proposition that any positive externality provided by agricultural production, in the form of the scenic beauty of the rural landscape, would be more than offset by negative externalities, mainly due to the use of farm chemicals. In addition, he suggested that if agricultural profitability were reduced in industrial countries, farm labour and capital would find employment mostly in the relatively ‘clean’ services or industrial sectors. For developing countries, Anderson (1992a; 1992c) argued that higher food prices may also improve the environment. He suggested that an increase in agricultural product prices would serve to increase employment and thus wages on commercial farms, thereby making alternatives to fuelwood more affordable, which may then slow down the deforestation process. He further argued that the capital required for the expansion of the agricultural sector might otherwise be employed in manufacturing or mining activities which might be more pollution-intensive than farming.
However, the suggestion that an increase in world food prices would improve the environment of developing countries is debatable. Lutz (1992), for instance, suggested that the net environmental effects of trade liberalisation in developing countries should be negative, but that trade liberalisation should be associated with generally positive overall environmental effects in industrial countries. At the global level, an empirical estimation would be needed to assess whether environmental benefits from agricultural trade liberalisation in industrial countries may outweigh costs in developing countries. Lutz (1992) assessed the environmental impacts of opening up food markets on the basis of a theoretical trade model, in conjunction with empirical estimates of relationships between agricultural input use and food price changes. He employed a simple partial equilibrium trade model to demonstrate that agricultural trade liberalisation in industrial countries would result in lower domestic prices, but would raise world market prices. The adjustment to reduced domestic prices in industrial countries would consist of reduced use of chemical inputs, machinery and land, with a positive impact on groundwater quality, biodiversity and soil erosion. In developing countries, in contrast, Lutz (1992) expected the overall environmental effects associated with trade liberalisation to be negative, mainly due to an increase in the use of agro-chemicals. However, if a developing country was a net exporter, the overall social welfare effect might still be positive due to higher international food prices.

Anderson and Tyers (1993) assessed how agricultural trade liberalisation would affect developing countries. They divided the food sector into seven commodity groups and chose a world of 30 country groups. Anderson and Tyers (1993) showed that even a food importing developing country might gain from trade liberalisation abroad, if the country switched sufficiently from being an importer to being an exporter of food, or if the importing country simultaneously reduced its own market distortions. The authors suggested that virtually all developing countries might benefit from a global liberalisation of food markets.

A case study of the liberalising of two specific agricultural markets was undertaken by Bohman and Lindsey (1997). They estimated the welfare effects of environmental policies and trade liberalisation in the North American sheep and lamb sector without, however, valuing the social costs of environmental externalities. Bohman and Lindsey (1997) formulated a partial equilibrium model and calculated changes in producer and consumer surplus as measures of welfare gain from the removal of tariffs. The data was based on border prices reported by the United States and production and consumption figures for 1990. The results showed that trade liberalisation had little impact on global welfare, but improved the welfare of an exporting country while worsening the welfare of an importing country.
Bohman and Lindsey (1997) argued that an increase in sheep production might add or offset positive or negative welfare changes, if externalities were included in the calculation, since externalities can be either positive or negative. Intensive livestock production and overgrazing may lead to nitrate leaching and soil erosion; however, extensive sheep production may improve soil conditions and thus reduce soil erosion. They also demonstrated that the US could take advantage of its market power through its influence on the terms of trade and thus enhance its welfare by imposing environmental regulation alongside trade liberalisation. The environmental policy would partially substitute for an optimal tariff policy.

2.3 Computable general equilibrium analyses

In addition to these empirical analyses, there have been an increasing number of studies, in recent years, analysing environmental and trade issues by means of computable general equilibrium (CGE) models. However, only a few studies have explicitly incorporated the agricultural sector into CGE models. The main aim of a CGE analysis is to evaluate policy options by converting the Walrasian general equilibrium structure from an abstract representation of an economy into realistic models of actual economies (Shoven and Whalley 1984). The advantage of the CGE models is that it allows a quantitative analysis of large dimensional models while the basic general equilibrium structure is the same as in their theoretical counterparts. Although CGE models are suitable for analysing environmental issues, the use of such models is a relatively new phenomenon (Wajsman 1995). This is because it is difficult to obtain formal algebraic solutions in even the most simple general equilibrium models, and the development of numerical algorithms that can find solutions to such problems has occurred only recently (Soedersten and Reed 1994).

Most CGE approaches which tried to incorporate environmental resources into trade models treated environmental policies as a source of increased production costs, with no direct impact on consumer well-being provided in the model specifications. Espinosa and Smith (1995), however, constructed a CGE model which reflected the effects of environmental degradation on consumers’ preferences. They attributed monetary values to pollutants after assessing their impact on human health. They also introduced a spatial dimension of environmental pollution into CGE models by allowing emissions to diffuse in different amounts to different regions. Espinosa and Smith (1995) showed that GDP gains from a reduction in non-tariff barriers for manufactured products in the UK would be substantially reduced if the morbidity and mortality effects of pollution were included in the calculation.
An early CGE study dealing with the environmental impact of trade policies, though not explicitly agricultural policies, was conducted by Perroni and Wigle (1994). The authors constructed a numerical general equilibrium model of the world economy with local and global environmental externalities. They assessed the relative contribution of trade liberalisation to environmental degradation, and the extent to which environmental policies would affect the size and distribution of the gains from international trade. Production was divided into six sectors and the environmental damage generated by each sector was estimated. Perroni and Wigle’s (1994) main finding was that a reduction of trade barriers would reduce environmental quality, although the relative contribution of international trade to environmental degradation would be relatively modest. They also showed that opening up to free trade would substantially improve global welfare, while environmental policy would have little effect on the size and distribution of the gains from trade liberalisation. This result was in contrast with other studies which had shown that certain environmental policies could have a significant impact on the world economy (Whalley 1991).

Beghin et al. (1995) included the agricultural sector in a CGE model when assessing the environmental implications of Mexico unilaterally exposing its market to the conditions of free trade. They employed an empirical economy-wide CGE model to evaluate pollution abatement policies and their effects on economic growth. Beghin et al. (1995) also assessed the impact of trade liberalisation on the environment and the interaction of a combination of environmental and trade policies. The results suggested that trade has two effects, a pro-growth effect, which is detrimental to the environment, and an output composition effect which mitigates environmental degradation. Agricultural production in Mexico would decline as a consequence of trade liberalisation, mitigating the negative environmental effects of agriculture. However, their results also indicated that the combination of trade and environmental policies might reduce the undesirable effects of each set of policies on their own.

Beghin et al.’s. (1995) analysis was taken further in a study focusing on the agricultural sector in Mexico and its specific pollution problems by Beghin et al. (1997). Agriculture was disaggregated into 22 sectors and pollution was represented by 13 different types of effluents. Beghin et al. (1997) found that trade liberalisation would raise national income and mitigate agricultural pollution. If environmental and trade policies were coordinated, the output of the polluting sectors would shrink even further, thereby reducing adverse environmental effects.
Van Der Mensbrugghe et al. (1998) investigated the implications of trade liberalisation and pollution taxes on aggregate income, pollution, and natural resource use in Chile, based on the same methodological framework as Beghin et al. (1995). They concluded that unilateral trade liberalisation by Chile would stimulate trade and induce a large increase in Chile’s GDP. However, trade liberalisation would also lead to higher levels of domestic pollution.

In conclusion, CGE case studies, similar to the empirical analyses, have by and large not been able to resolve the theoretical ambiguity as to whether international trade liberalisation increases national or global welfare. A general weakness of the CGE approach is its immense data intensity, combined with the difficulty in obtaining appropriate parameter values. In fact, a lack of reliable information concerning the social values of marginal agri-environmental effects at a global, or even a national level, seems to be the main limitation of using empirical or CGE models for the welfare analysis of agricultural trade liberalisation.

3 Trade and welfare implications of environmental policies

3.1 The effect of environmental policies on world welfare

Trade liberalisation may also have an influence on the design of environmental policies. In fact, environmental policies are often criticised for their use by governments as a substitute for conventional border protection measures. An important political task will therefore be to agree on criteria by which environmental policies can be classified as either trade-distorting, trade-neutral or trade-correcting (Latcz-Lohmann and Hodge 2001). The appropriate neo-classical approach to judge the trade-distorting character of environmental policies would be to measure them against their impact on global welfare. The rationale is that, if an environmental measure is beneficial to the world as a whole, an international redistribution mechanism could enable all countries to benefit from the policy, regardless of how benefits were distributed between the countries.

On a domestic level, a country would gain unambiguously from an environmental Pigou instrument if it simultaneously opened to trade (Anderson 1992b). However, as long as trade is not fully liberalised, the introduction of an environmental policy may not necessarily enhance social welfare, either on a domestic or on a global scale. A simple diagrammatic partial equilibrium trade model can illustrate that the internalisation of a domestic negative production externality would reduce pollution, but would also increase pollution associated with production abroad (Baumol and Oates 1988; Sutton 1989). Analogously, the
internalisation of a positive domestic production externality would enhance the provision of environmental goods in the country initiating this policy (Latacz-Lohmann 2000). This would reduce the world price, lower the production in other countries, and may thus produce less environmental amenities abroad. Merrifield (1988) came to conclusions similar to Baumol and Oates (1988), although he considered environmental policies addressing trans-frontier emissions within a general equilibrium model. He showed that the reduction in one country’s emissions may be more than offset if capital movements increased the other country’s output and emissions.

Copeland and Taylor (1994) demonstrated that strict environmental standards in one country may harm the environment of its trading partners. Their analysis was based on a two-country general equilibrium trade model, in a world where damage caused by pollution would be confined to the country of emission. Copeland and Taylor (1994) showed that if a rich country chose a higher pollution tax than its poorer trading partner, the pollution-intensive industries would locate in the poorer country, while the relatively clean industries would be concentrated in the richer country. The intensity of this effect would be dependent on the relative factor endowments being sufficiently different between the two countries.

An empirical study undertaken by Robison (1988) supported Copeland and Taylor’s (1994) theoretical findings. Robison (1988) formulated a seventy-eight-sector partial equilibrium model to estimate the trade impacts of industrial pollution abatement in the United States. He considered inter-industry effects, while ignoring offsetting general equilibrium effects such as changes in exchange rates. Robison (1988) found that US pollution control programmes changed the US comparative advantage, so that more high-abatement-cost goods would be imported and more low-abatement-cost goods exported.

One of the rare theoretical studies analysing explicitly the impact of domestic environmental policies on world welfare was undertaken by Latacz-Lohmann (2000). He extended Baumol and Oates's (1988) analysis and discussed how domestic environmental policies would affect other countries’ welfare. Latacz-Lohmann (2000) showed diagrammatically that if a large importing (exporting) country internalised a negative (positive) externality though a Pigouvian policy instrument, the welfare of its trading partner would be enhanced; that country's welfare would be diminished, however, if an importer (exporter) internalised a positive (negative) externality. Furthermore, he argued that the internalisation of a negative externality in an exporting country would augment world welfare. But, if an importer internalised an externality or if an exporter implemented a Pigou subsidy to internalise
positive external effects, the sign of the net world welfare outcome would be ambiguous, because one trading partner would gain whereas the other would lose.

In summary, there have been only a few studies analysing the global welfare implications of specific environmental policies. Externalities were commonly defined as production externalities and their internalisation consequently modelled as a production tax. Such simplification is helpful to analyse the welfare implications of environmental measures within a standard trade model, though it may not capture the full welfare effects of an efficient agri-environmental policy. Furthermore, the scenarios being investigated were based on the assumption that a country would introduce a Pigou measure. The latter would be the optimal policy for a small country facing a domestic environmental problem. However, it may be suspected that many governments have strategic incentives to protect domestic producers, particularly in agriculture. A large country might also aim to influence the terms of trade in its favour and thereby introduce a strategic environmental policy differing from a Pigou instrument. Although there have been numerous studies analysing countries’ domestically optimal environmental policy, the global welfare effects of strategic environmental policies have not yet been assessed, as will be discussed in the following section.

3.2 Domestically optimal environmental policies in open economies

Externality theory suggests that the optimal environmental measure to address domestic externalities in a small open economy is a Pigou tax or subsidy. If a production process led to trans-frontier pollution, however, the environmental tax maximising domestic welfare would only account for social costs occurring to domestic citizens; the externality would not be fully internalised. But a Pigou tax might even be sub-optimal for a country facing a domestic externality, if it is sufficiently large to affect world prices, as is demonstrated by Latacz-Lohmann (2000) within a diagrammatic partial equilibrium trade model.

Several authors have tried to specify the optimal environmental policy for a large country. Depending on the model specification, some studies have provided a theoretical basis for the practice of setting too lax environmental policies, whereas others have suggested that incentives may even be reversed. Bhagwati and Ramaswami’s (1963) two-sector diagrammatic general equilibrium model showed that the implementation of an optimal tariff would be the optimal policy for a large country. Bhagwati et al. (1969) and Kemp and Nagishi (1969) have built upon Bhagwati and Ramaswami’s (1963) study to demonstrate that in the presence of a domestic production externality, the simultaneous levying of both a tariff and a tax on production would raise domestic welfare. This result supported Lipsey and
Lancaster’s (1956) theory of the Second Best, suggesting that if an uncorrected distortion exists in one sector, then the optimising rules for the remaining sectors will generally no longer produce optimal resource allocation.

Vandendorpe (1972) extended Bhagwati et al.’s (1969) two-good general equilibrium approach to a multi-commodity trade model and determined algebraically the country’s optimal tax structure depending on whether the country would be restricted to consumption or production taxes. He showed that a country which has some market power in international trade, but is prevented from exercising this market power through tariffs, still has some room for exploitative manipulation of the terms of trade through its tax policy.

Markusen (1975) built upon Vandendorpe’s (1972) algebraic model and specified the optimality condition for a domestically optimal policy. While Vandendorpe (1972) considered a country which would be prevented from using tariffs, Markusen (1975) assumed that the government could choose a policy mix composed of production taxes, consumption taxes, tariffs and export subsidies. In Markusen’s (1975) model, a country faces a negative domestic externality, which would be produced in a fixed functional relation to the production of a single consumption good. He identified an equation suggesting that domestic welfare can be maximised by the introduction of a production tax and an appropriate trade tax. Whereas the producer’s tax would target the negative externality, the trade tax would be equivalent to an optimal tariff, making use of a country’s influence on the terms of trade.

Krutilla (1991) extended Markusen’s (1975) study by determining the domestically optimal environmental tax or subsidy for both negative and positive externalities. He showed that the domestically optimal environmental policy would partially substitute for an optimal tariff policy and thus deviate from a Pigou tax or subsidy. If the government of a large country wanted to take advantage of its market influence on its terms of trade, its optimal tax addressing a negative production externality would be greater (less) than the Pigou tax if it were a net exporter (importer). If an exporting (importing) country had to deal with a negative consumption externality, the optimal consumption tax would be less (greater) than the Pigou tax. Positive externalities, on the other hand, would require subsidies. The optimal subsidy for a net exporter (importer) facing a positive production externality would be a subsidy lower (greater) than the Pigou subsidy, but it would be greater (lower) than the Pigou subsidy if the same exporting (importing) country had to internalise a positive consumption externality.

While Markusen (1975) employed a two-commodity, two-country general equilibrium model,
Krutilla (1991) considered only one commodity without explicitly accounting for interactions between commodity markets.

Kennedy (1994), Conrad (1993) and Markusen et al. (1993) also showed that a large country would have a strategic incentive to set environmental tax rates unequal to the Pigou tax due to its influence on the terms of trade. Kennedy (1994) examined strategic incentives to distort pollution taxes from the perspective of a country to who the only policy instrument available is a pollution tax. Kennedy (1994) extended Krutilla’s (1991) model by allowing for trans-boundary pollution. He demonstrated that the size of the strategic distortion would depend crucially on the degree to which pollution is trans-boundary.

Rauscher (1994) showed that lower levels of environmental regulation in the export industry, as compared to the import and non-tradables sector, may be economically optimal, as it may improve a large country’s terms of trade. However, he also showed algebraically that in a particular (unspecified) parameter constellation the optimal environmental regulations for the export industry might be more restrictive than for the other sectors, depending on how this would affect the country’s terms of trade. Rauscher (1994) employed a three-sector model consisting of imports, exports and non-tradables and two factors of production. He assumed pollution and emissions to be of a purely domestic nature and treated them along with capital as a factor of production.

A different aspect of strategic environmental policies was investigated by Conrad (1993) and Ulph (1994b, 1996). Conrad (1993) established a model of international oligopoly with negative global production externalities to analyse optimal environmental policy responses to foreign emission tax and subsidy programmes. Ulph (1994b, 1996) analysed how optimal domestic environmental measures to address local pollution would change if governments and private producers acted strategically. He demonstrated that when producers are allowed to act strategically, the incentives of governments to relax environmental regulations in order to shift rents in their favour would be reduced. However, the relevance of Conrad’s (1993) and Ulph’s (1994b, 1996) studies for the analysis of agri-environmental policies is rather limited, since agricultural producers are usually not able to strategically influence market prices.

Several other studies have investigated firms’ optimal relocation decisions in response to the environmental standards being raised. Markusen et al. (1993) showed numerically that small environmental policy changes may cause firms to close or open a plant, or shift production to a foreign branch plant. They assumed that firms could make discrete decisions such as whether or not to serve another country by exports or by opening a branch plant in that region.
Ulph (1994a) extended Markusen et al.’s (1993) numerical model by allowing for strategic interactions between governments in setting their environmental policies. He concluded that there would be an incentive for governments to offer subsidies to producers to prevent them relocating to other countries. Furthermore, Barrett (1994) showed conceptually that if firms competed on prices (Bertrand competition) rather than quantities (Cournot competition), governments would have strategic incentives to impose even tighter environmental standards as compared to a Pigou instrument.

Location decisions of agricultural production processes, however, are mainly determined by conditions of soil productivity and marketing facilities. Hence, the suitability of the studies conducted by Markusen et al. (1993), Ulph (1994a) and Barrett (1994) for the analysis of agri-environmental policies seems to be rather limited. Even in non-agricultural sectors, there has been little empirical evidence in support of the theory that strict environmental regulations may reduce producers' international competitiveness, (Tobey 1990; Grossman and Krueger 1993; Bohman and Lindsey 1997). The lack of empirical support has been explained by the fact that environmental compliance costs are often too small a share of companies' cost structure to trigger the relocation of plants (Subramanian 1992; Buckley 1993). Some economists even argue that stricter environmental regulatory systems may enhance competitiveness to the extent that they lead to innovation and efficiency (Porter and Van Der Linde 1995; Tussie 1999).

4 Conclusions

The conceptual analysis of the welfare implications of trade liberalisation within a second-best world of environmental externalities has focused on the welfare impact on those countries which are opening up to trade. Conclusions as to whether the net welfare effects are positive or negative were, in many cases, ambiguous and further research would be needed to identify criteria under which opening up to trade increases national welfare. Empirical analyses and CGE case studies have on the whole not been able to resolve the theoretical ambiguity as to whether international trade liberalisation in agriculture increases national or global welfare. This is mainly because information about the social values of marginal agri-environmental effects are often not available. Given the criticisms of further trade liberalisation in the context of the WTO negotiations, the question of whether, and in what
circumstances, free trade enhances social welfare for the world as a whole, has not yet been resolved.

The model design for the analysis of the interaction of agricultural trade liberalisation and the environment has not significantly differed from those of non-agricultural sectors. In fact, the main approach has been to analyse welfare changes within a simple, standard textbook, diagrammatic partial equilibrium market diagram. There have been a few general equilibrium analyses; however, most studies have been silent on whether the linkages between agriculture and other sectors are strong enough to merit the additional effort of more complicated models.

The welfare implications of environmental policies have been analysed by an even smaller number of theoretical and empirical studies. Externalities were commonly defined as production externalities, and their internalisation modelled as a production tax. Such simplification has simplified the analysis of environmental policies, though it is unlikely to represent an optimal agri-environmental measure. The scenarios being investigated were based on the assumption that a country would introduce a Pigou measure. The only study analysing the welfare impact of a Pigou environmental measure was based on a two-country free-trade model in which the externality was assumed to be the only market imperfection. However, given the real-world trade barriers of agricultural markets, trade models would be needed to assess the welfare impact of environmental policies related to agricultural markets in a second-best world. No research has been undertaken as yet to answer the question how a Pigou measure would affect global welfare in the presence of protected domestic markets.

Furthermore, while a Pigou measure would be the optimal policy for a small country facing a domestic environmental problem, it may be suspected that, in agriculture, many governments have strategic incentives to protect domestic producers. A large country might even aim to influence the terms of trade in its favour and thereby introduce a strategic environmental policy differing from a Pigou instrument. Hence, another important area of future research would be to investigate how a large country’s optimal environmental policy would affect global welfare. Although there have been numerous studies analysing countries’ domestically optimal environmental policy, the welfare effects of such policies on other countries have not been analysed as yet.

A further research need relates to optimal environmental policies that would maximise world welfare. The globally optimal policy within a closed economy facing an environmental externality as the only source of market distortion would be the internalisation of externalities through a Pigou tax, assignment of property rights or emissions trading. Even if the closed-
economy assumption were relaxed, the same propositions of optimal environmental policies would hold, if the policies were aimed at maximising world welfare. The reason is that if trade were perfectly liberalised between countries, different nations could be regarded as regions within one closed economy. However, although trade is far from being free in many commodities, the academic community has yet to identify the globally optimal environmental policy within a second-best world.
5 References


