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Beyond the Green Box:

A Conceptual Framework for Agricultural Trade and the Environment

by

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"What can be done with less
is done in vain with more."

William of Ockham
1285-1349

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1. Introduction

The coevolution of environmental and trade policies since the end of the Uruguay Round has left governments and trade negotiators grappling with two central questions. The first question concerns the impacts of trade on the natural environment:

- When does trade impose such burdens on the natural environment that trade rules must be revised, or offsetting interventions made to protect environmental quality?

The second question concerns the impacts of environmental measures on trade:

- When do the burdens of environmental measures on trade justify their removal or reform?

Both of these questions arise from the interaction of trade and environmental measures. There are, of course, a large class of cases in which national environmental problems can be dealt with in ways that do not burden trade flows at all. Conversely, there are many issues of agricultural trade policy that are unrelated to environmental issues. An example of the former might be pollution in inland lakes and waterways requiring changes in agricultural practices in a watershed. An example of the latter might be the choice of a tariff versus a quota affecting imports of a commodity such as dairy products or sugar. But where trade and environmental measures ***do*** interact, resolving these issues requires explicit value to be given to environmental costs and benefits, which must then be weighed against the costs to the trading system of interference with the free flow of goods and services. The effect is to grant "standing" to environmental costs and

benefits that have often been ignored or discounted in the past (see Runge, et. al., 1994, pp. 31-33; Arrow, et. al. 1996).

As part of this trend, the Uruguay Round Agreement (Annex 2) designated certain agro-environmental policies as "green box," meaning that their impacts on trade were sufficiently small that they received a "green light" and would not be regarded as part of a country's Aggregate Measure of Support (AMS).[1] Such green box designations were extended not only to a variety of agro-environmental measures, but to policies affecting food security, crop insurance, and revenue support. In general, so long as a policy had little or no impact on production or prices, it was presumed to have little impact on trade, and was thus in the "green box." In fact, it is unclear whether strict trade neutrality, in the sense of ***no*** effect on prices or production, was as important to trade negotiators as that the programs not have ***positive production*** or ***negative price*** effects. The U.S. Conservation Reserve Program (CRP), for example, has clearly reduced U.S. crop production (by roughly 35 million acres annually) and indirectly raised prices, yet is designated as green box. However, these are the kinds of supply reduction and price supporting measures which farmers in competing countries, such as the EU, are likely to applaud. Furthermore, the presumption that neutrality respecting prices and production is the best indicator justifying exemption from trade disciplines is dubious. In this paper, I shall be concerned with whether a

[1]The intuition was that of triage, in that some policies with questionable trade impacts would be designated as "yellow" and those that clearly distorted trade were "red." In moving from green to yellow and yellow to red, the presumption in favor of including them in the AMS increased. It should be noted that "green box" does not use "green" in the sense of environmentalism. However, agricultural program payments with environmental objectives were granted green box status under two conditions in Annex 2 (p. 61) of the Uruguay Round Agreement. First, eligibility for the payments "shall be determined as part of a clearly-defined government environmental or conservation program and be dependent on the fulfillment of specific conditions under the government programme, including conditions related to production methods or inputs." Secondly, the payment amount "shall be limited to the extra costs or loss of income involved in complying with the government program." For a discussion, see Ervin (1999).

more general characterization can be given to environmental (or other) policies that are justified, ***even if*** they affect trade, and the converse question of under what conditions trade policies with negative environmental impacts must require discipline. These actions and decisions may occur through consultation, negotiation, or formal rule changes (see Sampson, 1999).

I begin with a discussion of the welfare economics of these issues, then develop a decision-theoretic framework, and a set of evidentiary criteria that help to justify certain policy measures. While the discussion is conceptual, I propose some specific examples. I then consider the relevance, as well as some limitations, of an approach based on the theory of economic policy known as targets and instruments (Tinbergen, 1950), and suggest a reinterpretation based on the theory of joint production. I conclude with a critique of the recent enthusiasm for justifying status quo measures (especially in the EU), under the rubric of "multifunctionality."

2. Trade Reform and Social Welfare

The debate over agricultural trade liberalization in the post-Uruguay Round period revisits arguments from the New Welfare Economics (circa 1938-1950) and the debate over the Kaldor-Hicks compensation tests (Chipman and Moore, 1978). Hicks' (1939) assertion of the efficiency gains of trade liberalization came in the context of the historical repeal of England's Corn Laws, which had sought to raise real national income by liberalizing protective agricultural tariffs. Harrod (1938, pp. 396-397) had argued that the consequence of liberalizing the Corn Laws was to reduce the value of land, into which the benefits of protection were capitalized. Hicks (1939) and Kaldor (1939) proposed that if such losses could in principle be compensated, then trade liberalization could objectively be shown to be "potentially Pareto-superior" to retaining protective tariffs. Yet critics of the compensation tests, notably Samuelson (1950), argued that

unless an unambiguous increase in social welfare resulted, in which everyone was made better off from the change, evaluating the relative merits of such a policy shift would require a social welfare function, in which the welfare losses of one individual or group were explicitly weighed against the gains of others. As Chipman and Moore (1978, p. 580) noted, the debate over compensation ultimately led "to a very different conclusion than the founders of the New Welfare Economics had in mind: the need for an activist policy for the determination of the distribution of income and wealth, rather than exclusive reliance on market forces combined with a given pattern of private ownership of resources."

Advocates of agricultural trade liberalization thus have no theoretical foundation to claim that if general benefits are sufficiently great, those that lose from the changes can either be ignored or compensated in principle. Rather, a key part of trade liberalization will be to define a social welfare function that provides explicitly for compensation for various losses, and to design activist policies to compensate for and remediate damages, including those to the environment. In this spirit, advocates of the North American Free Trade Agreement (NAFTA) enlarged the negotiation to include explicit attention to labor conditions and job losses, and created a North American Commission on Environmental Cooperation (CEC) to monitor and evaluate environmental impacts, as well as a North American Development Bank to offer financing for infrastructure projects along the U.S.-Mexico border. While critics of NAFTA assert that these measures were inadequate, they nonetheless showed that the total effects of trade liberalization on social welfare require attention not only to allocative efficiency, but to issues of distribution and market failure. In the specific case of market failures arising from environmental externalities, Anderson (1992) made the point most forcefully, concluding that the welfare effects of liberalizing trade would be ambiguous if environmental externalities were left uncontrolled, and can only be

assured if such externalities are internalized by appropriately targeted measures. Thus, maximizing the welfare benefits of trade liberalization carries with it an obligation to activist environmental policies.[2] While these results are unsurprising to well-schooled economists, it is important to restate them in justification of the exercise to follow.

3. A Decision Framework

How, then, can nations respond to the ***particular*** environmental effects of trade measures? Conversely, how can ***particular*** environmental policies be justified that may pose burdens for the trading system? We will consider each question in turn, treating them in a decision-theoretic manner.

3.1 Trade Effects on the Environment

We begin with a description of the impacts of trade on the environment, following Runge, et. al., 1994. Figure 1 is a decision tree, in which the first branches result from an "event node," where one or another outcome may occur (see Raiffa, 1970). In decision analysis, it is customary to assign probabilities to the branches of an event node, reflecting information about the likelihood of alternative outcomes. Clearly, the greater the likelihood that a trade measure may lead to environmental damages, the more scrutiny the trade measure will require.[3] If the trade

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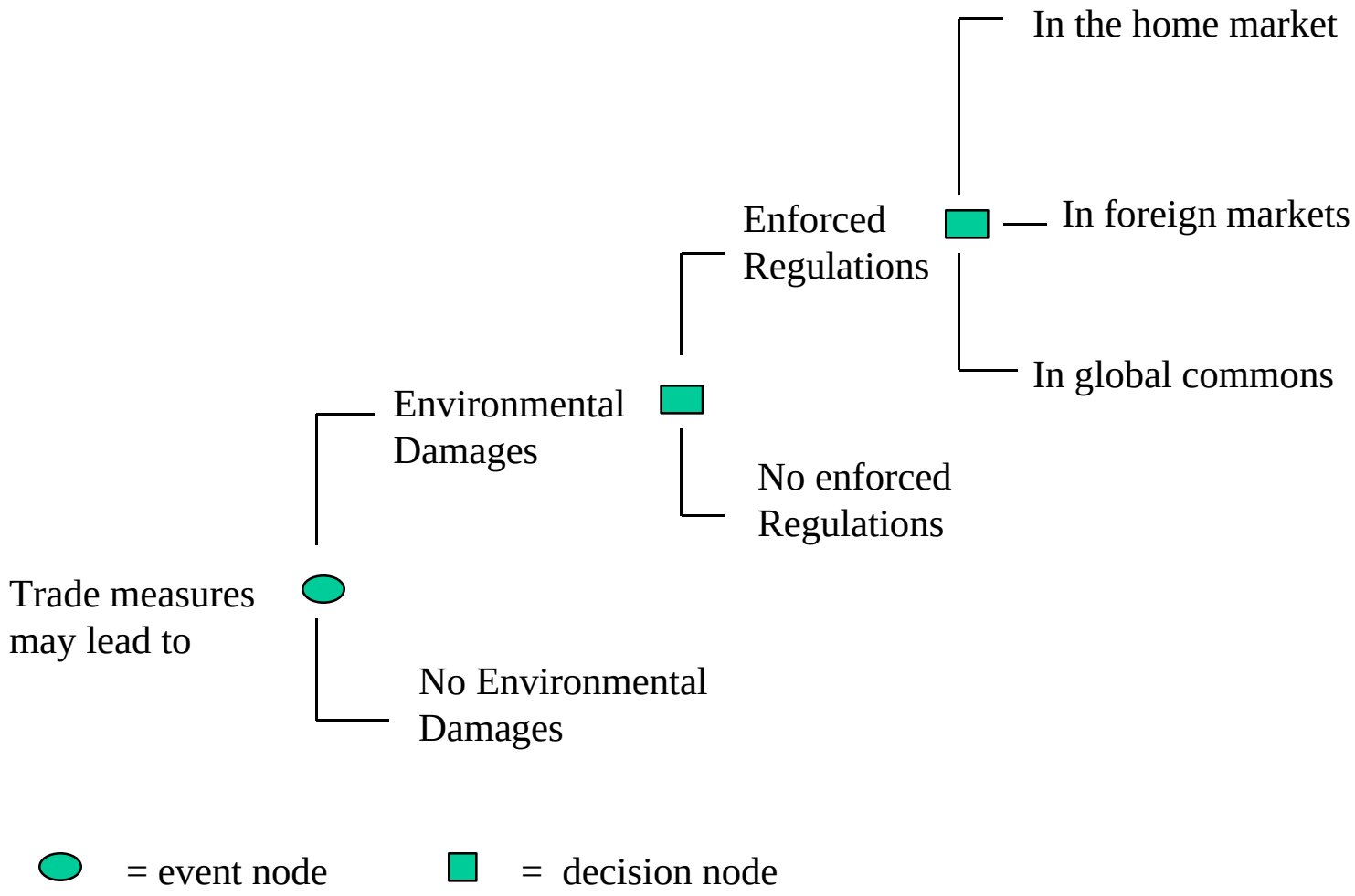
[2]A parallel argument applies respecting labor standards and job losses.

[3]In scrutinizing trade measures, an important question is whether trade is the primary cause of environmental damages. Experience with NAFTA shows that it is often difficult to isolate the pure effects of trade on the environment, although quantitative and qualitative judgements can be made. In a case study of the North American cattle feedlot industry (Runge and Fox, 1999), for example, linkages from NAFTA to various shifts in cattle production, and their environmental implications, were clearly identified. Judgements must then be made concerning an appropriate regulatory response. Striking a balance between trade and the environment requires a careful assessment of the cost of minimizing environmental damages, and the fact that additional environmental regulations are not free. Fundamentally, this is a matter of offsetting damages linked to trade by choosing the best in a set of regulatory alternatives, including changes in

measure itself is not abandoned or altered as a result of such a likelihood, then the environmental damages may lead to some type of regulatory decision (taxes, subsidies or other measures may clearly be part of this decision). For this reason, the next set of branches are marked as "decision nodes." The decision tree allows for the possibility that a decision not to enforce regulations may be made. This outcome is especially relevant where the institutional and/or regulatory infrastructure is undeveloped, or where the political system is indifferent to the environmental damages involved, both of which are distinct possibilities in parts of the OECD and in less developed countries (see Runge, 1998).

economic incentives though taxes, subsidies, or fees.

Figure 1. ENVIRONMENTAL AND REGULATORY IMPLICATIONS OF TRADE MEASURES
Source: Adapted from Runge, et.al., 1994, p. 12.



Once a decision to respond to environmental damages has been reached, there are further decisions that must be made over the appropriate venue and jurisdictional boundaries within which to proceed (see Hauer, 1998). For example, even if trade is linked to environmental damages, the damages may occur outside the home market, beyond the reach of domestic laws. Such was the case in the "tuna-dolphin" dispute, when the United States imposed trade embargoes to enforce laws designed to prevent dolphin kills in fishing nets used to catch tuna in foreign waters.[4] In such cases, regulation takes on international legal significance, and questions of jurisdiction and sovereignty arise. Whether the trade measure has its primary environmental impact at home, abroad, or in the "global commons" (such as the atmospheric ozone layer), will affect decisions to take action in response.

In summary, Figure 1 shows the basic elements of events and decisions where trade affects the environment. A trade measure (for instance, an export ban or market integration process, such as NAFTA) may lead to environmental damages or it may not. If the likelihood of damages is high, offsetting them requires either that the trade measure itself be changed, or a decision in favor of some type of enforced regulatory response. The venue for this implementation and enforcement may be the home market, foreign markets, or even the global commons, as in the case of the atmospheric ozone layer. The wider the scope of intervention, the more complex issues of jurisdiction and sovereignty become, necessitating greater consultation, negotiations, or rule changes.

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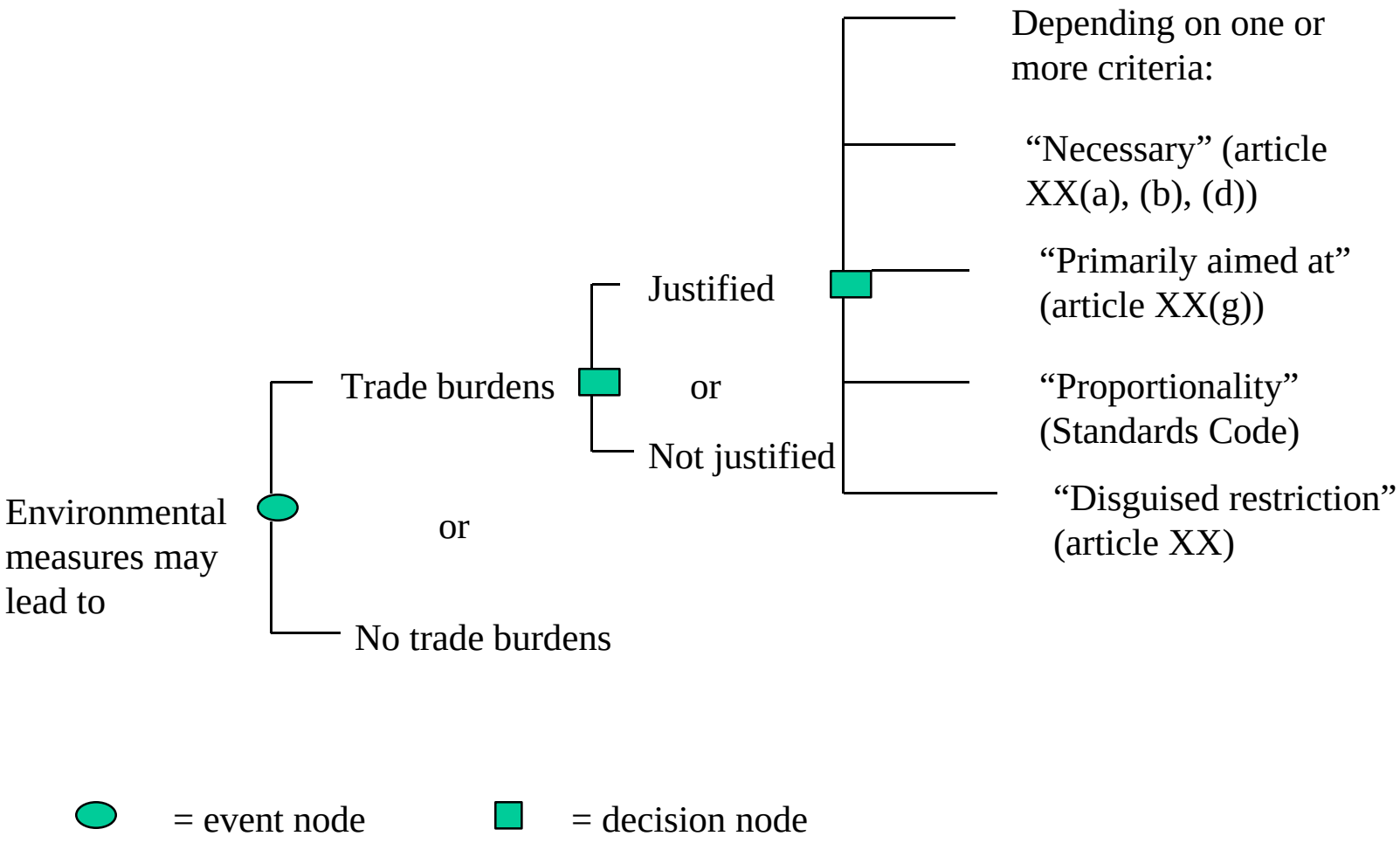
[4]United States--Restrictions on Imports of Tuna. GATT Doc. No. DS21/R. September 3, 1991.

3.2 Effects of Environmental Measures on Trade

In contrast to the impacts of trade on the environment, measures designed to protect the environment may also affect trade. This sequence of events and choices is shown in Figure 2, a decision tree with slightly different features than the preceding one. The first branches describe an event node: environmental measures may lead to burdens by diverting or stopping trade flows, or they may not. If the likelihood of such trade diversion or stoppage is high, particular scrutiny of the environmental measure is required. If a demonstrable burden is imposed on agents seeking to export or import goods or services in the name of environmental protection, the next question involves a decision. This balancing decision is whether the environmental measure is justifiable environmental protection or is instead mainly a disguised restriction to trade, in which harmful trade effects offset and may outweigh beneficial environmental effects. This decision requires explicit weighing of the costs (to social welfare due to trade distortion) that should be borne in order to protect benefits of a healthier natural environment. As Hudec and Farber (1992) argued, such questions typically break down into two parts. First, does the environmental measure create a burden on the trading system? Second, is the burden nonetheless justified by the welfare benefits of the environmental measure?

Figure 2. TRADE IMPLICATIONS OF ENVIRONMENTAL MEASURES
Source: Adapted from Runge, et. al., 1994, p. 16



From a legal perspective the burden imposed on trade is a gateway concept. If no burden is found, then the trade effects of the environmental measure are not at issue. The finding of a burden opens the way to further decisions as to a measure's justification, in which its benefits for the environment are weighed against its harm to trade. This justification depends on specific legal tests applied by the WTO/GATT dispute settlement procedures.

These tests all amount to decisions implicitly balancing the environmental benefits of the measure against the harm it does to trade. The first and simplest is the "necessary" test.[5] "Necessity," in this context, means that the environmental goal cannot be realistically accomplished by means that are less burdensome to trade. As Hudec argues, whether a burdensome regulation is "necessary" to achieve a domestic environmental objective "is really an interlocking decision about whether, as compared with the next least restrictive alternative, the extra burden is worth the extra gain."[6]

A second test applied to environmental measures is the "primarily aimed at" test. Is the environmental measure primarily aimed at resource conservation, and not at some other (presumably protectionist) objective? In a case heard before both a GATT dispute resolution panel and a Canada-U.S. Free Trade Agreement (FTA) panel (see Runge, et. al., 1994), the required landing in Canada of 100 percent of U.S. salmon and herring catch to be counted for "conservation purposes" was found to be invalid. The panels concluded that the regulations were

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[5]This is provided for in GATT articles XX(a), (b), and (d). These general exceptions allow measures to be undertaken for domestic reasons even if they impose burdens on trade. Under article XX(b), for example, measures must be "necessary to protect human, animal or plant life or health." Article XX(g) is the most explicitly environmental, calling for exceptions in the case of measures designed to promote the "conservation of exhaustible natural resources," if such measures are accompanied by similar domestic restrictions on production or consumption.

[6]Robert Hudec, personal communication.

not primarily aimed at conservation. The FTA panel, in particular, reasoned that the Canadian government would not have imposed the regulation for conservation purposes if the full burden had fallen on Canadian citizens. Hence, given the legitimacy of the conservation goal (preserving the salmon and herring fishery), the question of whether the environmental measure was primarily aimed at this goal reduced to whether the extra gain in environmental terms of counting 100 percent of the catch was worth the added burden on trade. The "primarily aimed at" test can be thought of in terms of cost-effectiveness: is the trade-distorting measure (assuming that its goals are legitimate for conservation purposes) the most cost-effective way of protecting the environment, or are there more direct ways of doing the same thing that impose fewer burdens on trade?

A third test comes from the 1979 Standards Code, developed in the Tokyo Round of multilateral trade negotiations, known as "proportionality." Here, as in the "necessary" and "primarily aimed at" tests, a balance ("proportionality") is sought between the benefits of the environmental measure and its costs in terms of trade restriction. The environmental goals defined as legitimate are assumed, so the question reduces to whether the measure is "more trade restrictive than necessary" to reduce the risks "nonfulfillment would create."

A fourth test is the "disguised restriction" test.[7] In effect, it simply restates whether a measure is really protectionism "in disguise." In practice, this test differs little from the "primarily aimed at" test.

In summary, if an environmental measure imposes a burden on trade, whether the burden is justified can be assessed using several criteria. All appeal to the idea that if feasible alternatives

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[7]This test arises from the preamble to GATT article XX: a measure may not be applied in a way that is a "disguised restriction on international trade."

exist that are less trade-distorting, but still protect the environment, then they should be considered in lieu of existing measures. Ervin (1999) has proposed an additional set of justifications to "GATT-proof" agroenvironmental measures in the form of a "Code of Good Process." These justifications overlap substantially with those described above. They include:

- specifying clear environmental objectives for the programs
- clarifying property rights in environmental payments
- preferring the least trade distorting instrument
- establishing scientific linkage between the environmental objective and the program instrument
- implementing monitoring and evaluation to document program efficacy
- applying equal treatment for domestic products and imports
- ensuring the transparency of agroenvironmental measures

In order to establish these desiderata, however, certain types of evidence will be needed. We turn now to three key evidentiary criteria required when trade may affect the environment, or when environmental measures affect trade.

4.1 Evidentiary Criteria

In this section, a set of general criteria are proposed to help organize the evidence in both of the decision processes outlined above. Their purpose is to assist in answering the two questions identified at the outset of this study, respecting trade impacts on the environment, and the impacts of environmental regulation on trade. In either of these decision processes, three

types of evidentiary criteria can be applied (see Figure 3). The first of these is an empirical requirement: a finding of damage or burden. In the case of trade measures with damaging effects on the environment, careful documentation, including the use of well-defined environmental indicators, is needed to show how trade expansion is likely to lead to environmental damages. This empirical documentation is valuable not only in establishing the linkage, but in designing appropriate policies to offset or mitigate the damages. In the case of environmental measures that may pose burdens for the trading system, the same level of empirical rigor is necessary. If it is alleged that an environmental policy imposes trade burdens, careful documentation will be needed not only in establishing a case, but in designing alternative measures that are less trade distorting.

The second evidentiary criterion concerns the opportunity set of alternatives available to policymakers, which requires that a specific set of feasible alternatives be identified.[8] In the case of trade impacts on the environment, these would include either adjustments in trade policies designed to reduce environmental damages, or environmental safeguards introduced to mitigate or offset them. In the case of environmental measures with trade effects, it would include alternative environmental measures that might be less burdensome to freer trade. What is important is that these alternatives be ***feasible in practice, and not wholly hypothetical***. First preference would go to alternatives that are already in practice, obviating a demonstration of feasibility and eliminating hypothetical judgments.[9] Feasibility implies that these alternatives, even if not identical in costs, be within the budget set, and be capable of implementation and execution. Where such policies do not exist, evidence must be adduced showing that they are affordable and

[8]This discussion echoes Samuelson's (1950) analysis of "feasibility constraints" and social welfare.

[9]This point relates to the rejection of compensation schemes that are only hypothetical in nature, consistent with a rejection of "potential" compensation (see Samuelson, 1950).

can be implemented in principle.

The purpose of this criterion is to show rigorously that alternatives exist which may offer the same degree of trade liberalization with fewer environmental damages, or the same level of environmental protection with fewer burdens to freer trade. This demonstration is logically prior to judgments about whether an environmental measures is necessarily the "least trade restrictive," or whether a trade measure is least damaging to the environment, since use of "least" implies that feasible alternatives exist. The test also relates to questions of necessity, proportionality, and whether the measures are "primarily aimed at" their targets. A measure is necessary to protect the environment, for example, if and only if no other measure can feasibly accomplish the same goals, thus requiring the examination of actual or hypothetical alternatives. Judgements of proportionality are based on whether a measure imposes too great a burden on trade in relation to its environmental objective. Assuming the objective is valid, "too great" implies that a feasible alternative (including the alternative of no measure at all) must be considered. The "primarily aim at" test, while it does not logically require alternatives, clearly rests on a comparative judgement about the efficacy of different policies.

The third evidentiary criterion concerns the distribution of costs and benefits of a given measure.[10] This arises from the fact that different trade measures may impose different patterns of environmental burdens (costs) in relation to commercial trade advantages (benefits). Conversely, different environmental measures may impose different patterns of trade burdens (costs) in relation to their environmental advantages (benefits). Choices among feasible alternatives are

[10]Motivation for this criterion arises in part from conclusory arguments over the "primarily aimed at" test developed in the U.S.-Canada case respecting salmon and herring catch requirements imposed by Canada on the U.S. fishing fleet. See Runge, et. al. (1994), pp. 80-87.

likely to be affected by this distribution of costs and benefits. For example, if an environmental measure restricts trade, but imposes more burdens on foreign competitors than domestic producers, and alternatives exist in which the burden would be more equally shared, it may argue in favor of replacing the measure with this alternative.[11] In the case of trade policies which pose hazards for the environment, those which offer economy-wide benefits in relation to narrowly drawn environmental costs (for example, to a particular geographic area or ecosystem), may be more easily dealt with through a targeted environmental intervention than those in which commercial benefits flow to a narrow set of interests, whilst imposing widespread ecological damages. Similarly, when environmental policies offer widespread benefits, and their costs are borne narrowly by affected parties (such as a sector or firm), it is easier to target this group for direct compensation, whilst retaining the widespread advantages of environmental protection.[12]

Taken together, the evidentiary criteria summarized in Figure 3 are designed to narrow the search for those trade policies which, if damaging to the environment, may have feasible alternatives that are less damaging or, failing that, in which opportunities exist for narrowly targeted environmental interventions to mitigate or offset these damages. In cases in which

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[11]This was, in fact, the argument made in connection with landing rights for salmon and herring fished off the west coast of Canada in *U.S.-Canada Binational Panel Final Report, ITRD*, Vol. 12 (October 16, 1989): pp. 1026-44. The report read in part: "...the issue must be posed in terms of whether Canada would have adopted the landing requirement if that measure had required an equivalent number of Canadian buyers to land and unload elsewhere than their intended destination" (para. 7.09-7.10, pp. 1036-1037).

[12]The economic logic underpinning this argument arises from both the calculation of net welfare benefits and the theory of public choice. If each individual or firm is granted similar weight in calculating a sum of net benefits, and the benefits received are approximately equal (and issues of extreme intensity of preferences are disregarded [see Gorman, 1953]), then the more widely distributed are net benefits, the more likely is the maximization of welfare benefits -- an approximate restatement of Bentham's argument for the "greatest good for the greatest number." Public choice theory (see Meuller 1997) predicts that trade protection is most likely to arise from narrow interests through rent seeking, while environmental protection (a public good) is likely to fall short of full provision because its benefits are widespread and costs more narrowly distributed.

environmental policies impose burdens on the free flow of trade, the three criteria are designed to encourage alternatives that have fewer trade effects, and those in which benefits are widespread while costs are borne narrowly, accommodating compensation to those burdened. In either case, the purpose is to inform the decision framework where trade and environment intersect so that where this intersection poses either environmental damages or trade burdens, these burdens are minimized in relation to trade and/or environmental benefits.

FIGURE 3. EVIDENTIARY CRITERIA

Evidentiary Criteria	Trade → Environment (see Figure 1)	Environment → Trade (see Figure 2)
• Empirical finding of damage or burden	Evidence that links trade measure to damages to environment	Evidence that links environmental measure to trade burdens
• Opportunity set of alternatives	Evidence that feasible trade policy alternatives (or environmental safeguards) exist	Evidence that feasible environmental policy alternatives exist
• Distribution of burden (costs) and advantages (benefits)	Evidence that trade policies offer widespread benefits and narrow (more easily targeted) environmental costs	Evidence that environmental policies offer widespread benefits and narrow (more easily targeted) costs to the trading system

Source: The author.

4.2 Some Examples

Let us consider a representative case of each decision process, together with the evidentiary criteria noted. First, consider the impact of NAFTA on a particular sector, such as the North American beef feeding industry. This was the subject of an issue study prepared for the NAFTA Effects Project for the North American Commission on Environmental Cooperation (Runge and Fox, 1999). First, empirical evidence was developed showing that trade expansion under NAFTA would contribute to a process of consolidation of beef feeding already underway in the central U.S. and in the Prairie Provinces of Canada. Second, the environmental impacts were identified as occurring primarily in the feed grains sector, and indicators such as atrazine applications and nitrate levels in ground and surface waters were suggested as a basis for monitoring these effects. Since NAFTA's trade benefits are large and widespread in both the cattle and feed grains sectors, environmental interventions were discussed that focused primarily at the more narrow base of farm practices and feedlots, where specific environmental targets could be most easily met. These environmental safeguards were discussed as appropriate adjuncts to expanded North American trade in agriculture.

In the case of environmental measures with trade effects, the aforementioned U.S.-Canada dispute over landing of salmon and herring catch is instructive. The U.S.-Canada salmon-herring case illustrates a clear line of reasoning from a finding of trade burden to a lack of justification for the burden in terms of environmental protection. It does so by developing an empirical assessment of the need for 100 percent versus partial sampling, a feasible (and non-hypothetical) alternative. Finally, it shows that the landing requirements imposed on the United States would probably not have been undertaken by Canada if the distribution of the burden had been such as to fall wholly on its own nationals.

> In other words, how genuine the conservation purpose of a measure is, must be determined by whether the government would have been prepared to adopt that measure if its own nationals had to bear the actual costs of the measure...
>
> ... the issue must be posed in terms of whether Canada would have adopted the landing requirement if that measure had required an equivalent number of Canadian buyers to land and unload elsewhere than at their intended destination.[13]

5. Targets, Instruments and Joint Products: The Technology of Policy

We turn now to an issue implicit in much of the preceding discussion: the relationship between policies and goals or, in the language of economic policy, "targets and instruments." A principle of economic planning developed by economist Jan Tinbergen (1950) is that in general each target of policy merits a separate instrument. Tinbergen derived this prescription from the identification of a set of equations in which a programming problem can be solved only if the number of unknowns equals the number of equations (a necessary but not sufficient condition). This principle can be interpreted to mean that environmental targets are generally best met by environmental policies, and trade targets by trade policies.[14] If an appropriately balanced combination of environmental and trade policy measures is found, the result can be welfare gains both from the trade reforms ***and*** from improvements in the level of environmental quality. In general, therefore, some ***combination*** of trade and environmental policies will be most efficient.[15]

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[13]U.S.-Canada Binational Panel Final Report, para. 7.09-7.10, pp. 1036-37.

[14]Runge, et. al., 1994, pp. 28-30.

[15]See Kerry Krutilla, "Environmental Regulation in an Open Economy," *Journal of Environmental Economics and Management*, vol. 20 (1991), pp. 127-142. The targets and instruments distinction was first developed by Jan Tinbergen in *On the Theory of Economic Policy* (Amsterdam: Elsevier, North Holland, 1950).

Conversely, the advantages of trade policy reform can be lost if appropriate environmental actions are not undertaken jointly (Anderson, 1992; Repetto, 1993).

Yet the problems discussed above already assume that some cross-order effects from trade instruments to environmental targets, and vice versa, are at hand, complicating the neat identification of a single target with a single instrument. Notwithstanding the mathematical rigor of Tinbergen's argument, the political process is often drawn to solutions in which a particular instrument is supported as a solution to multiple problems. Arguments in favor of the "multifunctionality" of agricultural subsidies, especially in the EU, are motivated by the claim that single instruments succeed in hitting multiple targets, thus enhancing their value to numerous groups. The political reasoning behind these claims is not only that a single instrument achieves multiple goals, but that multiple constituencies can be enlisted in support of the instrument, each of which contributes its political clout because of its own interest in a separate target. It thus appears that Tinbergen's argument, reflecting the logic of indicative social planning, runs into the logic of coalition formation in democracies.

One way to square the apparent contradiction is to note that certain policy instruments may yield *joint products,* and that these products will adjoin the accomplishment of a particular policy target.[16] This approach leads to an analysis I will term the "technology of policy." Such joint products may be positive or negative from the perspective of social welfare. Thus, trade liberalization which reduces or eliminates subsidies in a sector such as fisheries may also lead to environmental benefits in the form of conserving depleted fisheries stocks, whilst the continuation of fleet subsidies perpetuates overfishing (see Runge and Jones, 1996). In such cases,

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[16]I am indebted to David Ervin for the suggestion that the theory of joint products be applied to this issue.

environmental interests will form coalitions with free traders. In agriculture, there is a considerable recent literature supporting the claim that agricultural protectionism is also harmful to the environment (Faeth, 1996). These negative joint products of agricultural subsidies (multidysfunctionality") must be weighed against claims of "multifunctionality," which emphasize only positive joint products (e.g., landscape preservation) that come with continued agricultural protection.

When one policy results in multiple outputs, the result is thus analogous to the case in which several products are produced from a single production technology. Two or more outputs (e.g., farm income support and landscape preservation) occur jointly as a result of a single policy x, just as wool and mutton are joint products of sheep production. Following Henderson and Quandt (1971), such a multiple output-single input production function $x = h(q_1, q_2)$ occurs when outputs are restricted to a combination of (q_1, q_2), where x is an agricultural subsidy, q_1 is farm income support and q_2 is landscape preservation, and the support of q_1 carries with it (precludes nonzero production of) q_2. A product transformation curve is the locus of q_1 and q_2 that can be secured from a given input of x: $x^0 = h(q_1, q_2)$, which with neoclassical assumptions yields a characteristic product transformation curve of q_1 and q_2 that can be secured from a given level of agricultural subsidy (see Figure 4).[17]

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[17]The slope of the tangent to a point on a product transformation curve is the rate at which q_2 must be sacrificed to obtain more q_1 (or q_1 sacrificed to obtain more q_2) without varying the input of x. The negative of the slope is defined at the *rate of product transformation* (RPT):

$$\text{RPT} = -dq_2/dq_1$$

Taking the total differential

$$dx = h_1\, dq_1 + h_2\, dq_2$$

Since $dx = 0$ for movements along a product transformation curve,

As shown in Figure 4, higher levels of agricultural subsidy ($x^3 > x^2 > x^1$) lead to higher levels of both income support and landscape preservation, in a changing ratio determined by the curvature of the transformation curve. Note that the curvature of the transformation curve may not imply a linear expansion path E, but may be biased in either direction. Specifically, increasing levels of agricultural subsidy may lead to higher levels of farm income without proportionate gains in landscape preservation, or vice versa (see Figure 5). Finally, as noted above, the outputs of a given policy may be expressed in terms not only of goods, but bads. If agricultural subsidies continue to support farm income q_1 and

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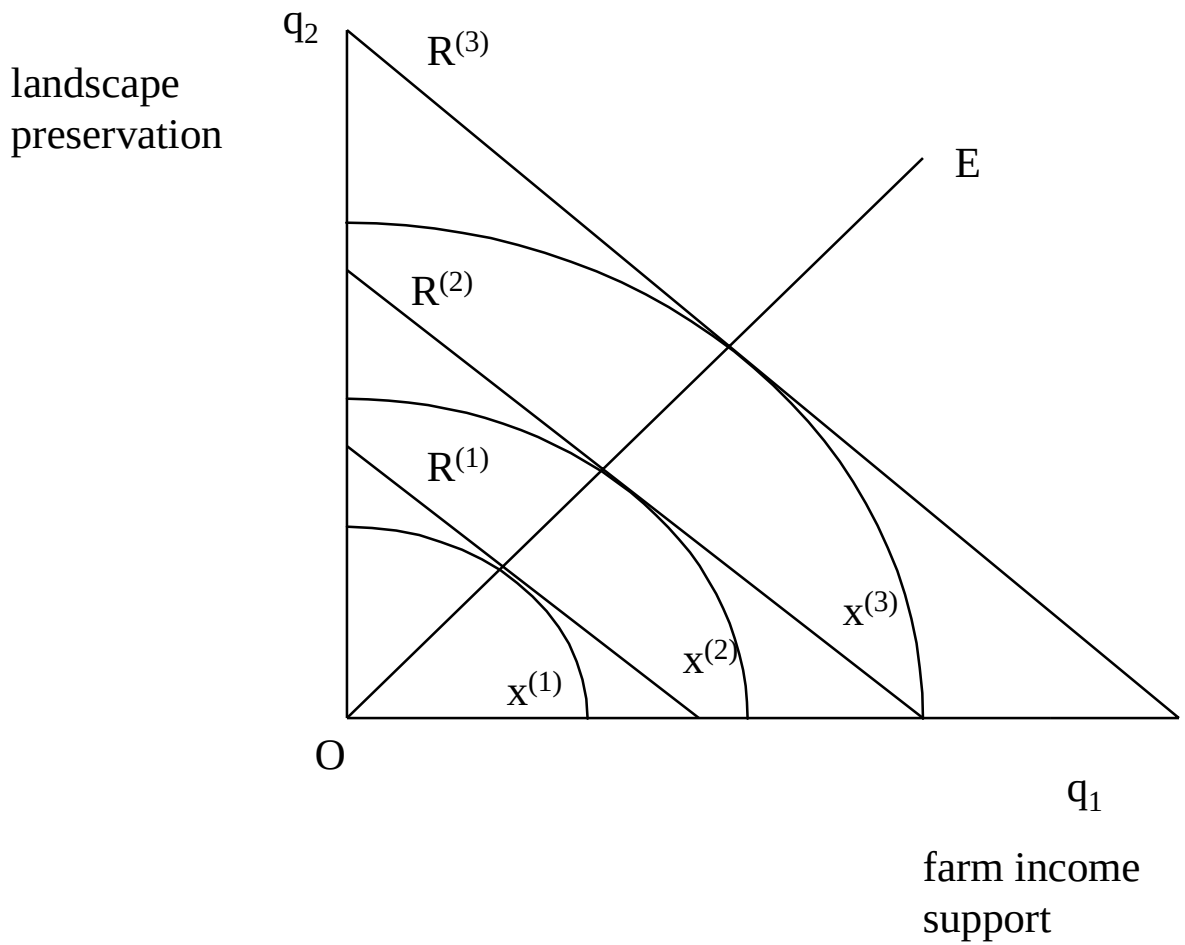
RPT = $-dq_2/dq_1 = h_1/h_2$

The RPT at a point on a product transformation curve equals the ratio of the marginal cost of q_1 *in terms of x* to the marginal cost of q_2 *in terms of x* at that point (Henderson and Quandt, 1971, p. 90).

Figure 4.



Source: Henderson and Quandt, 1971, p. .91

Figure 5.

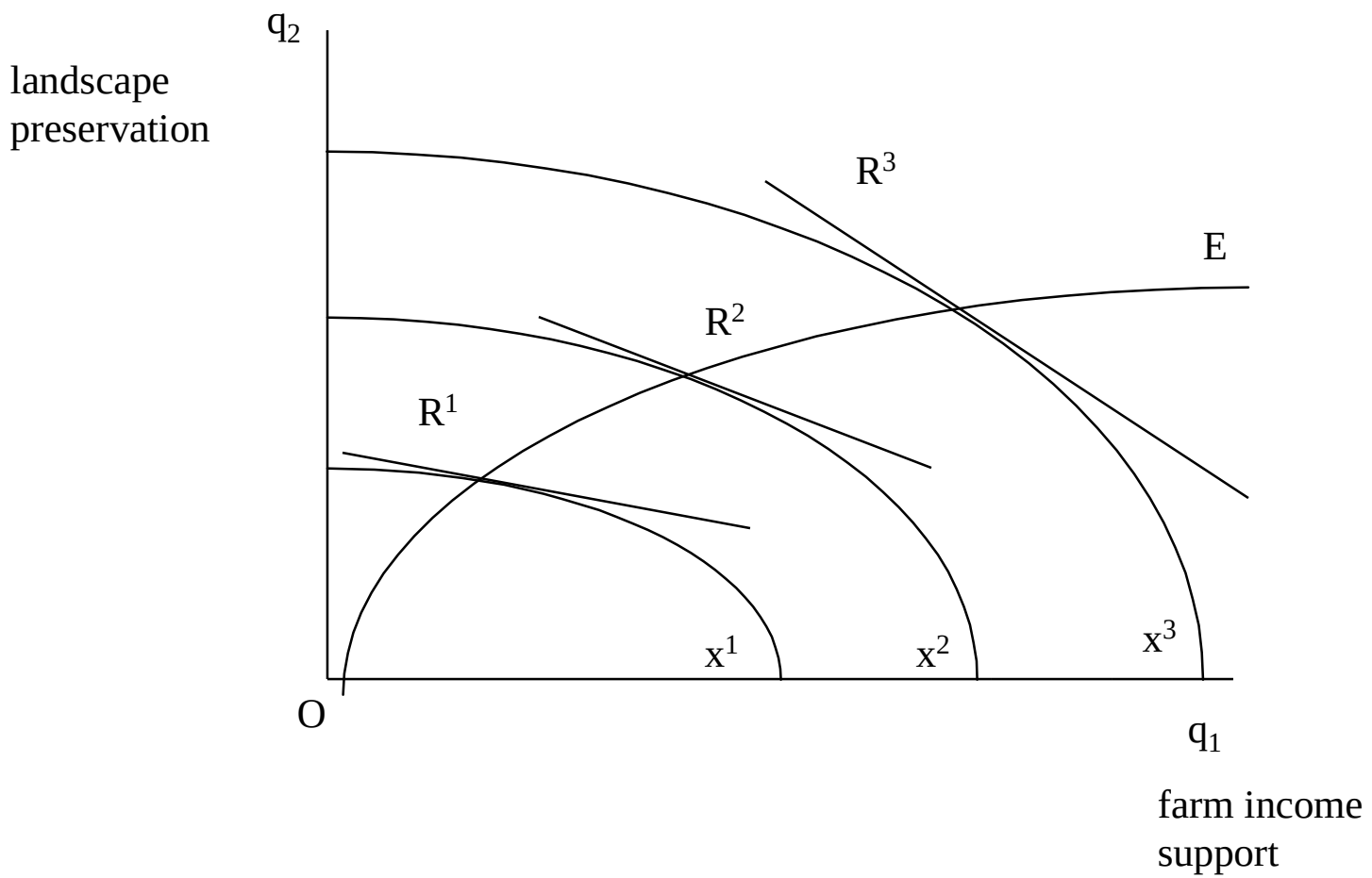
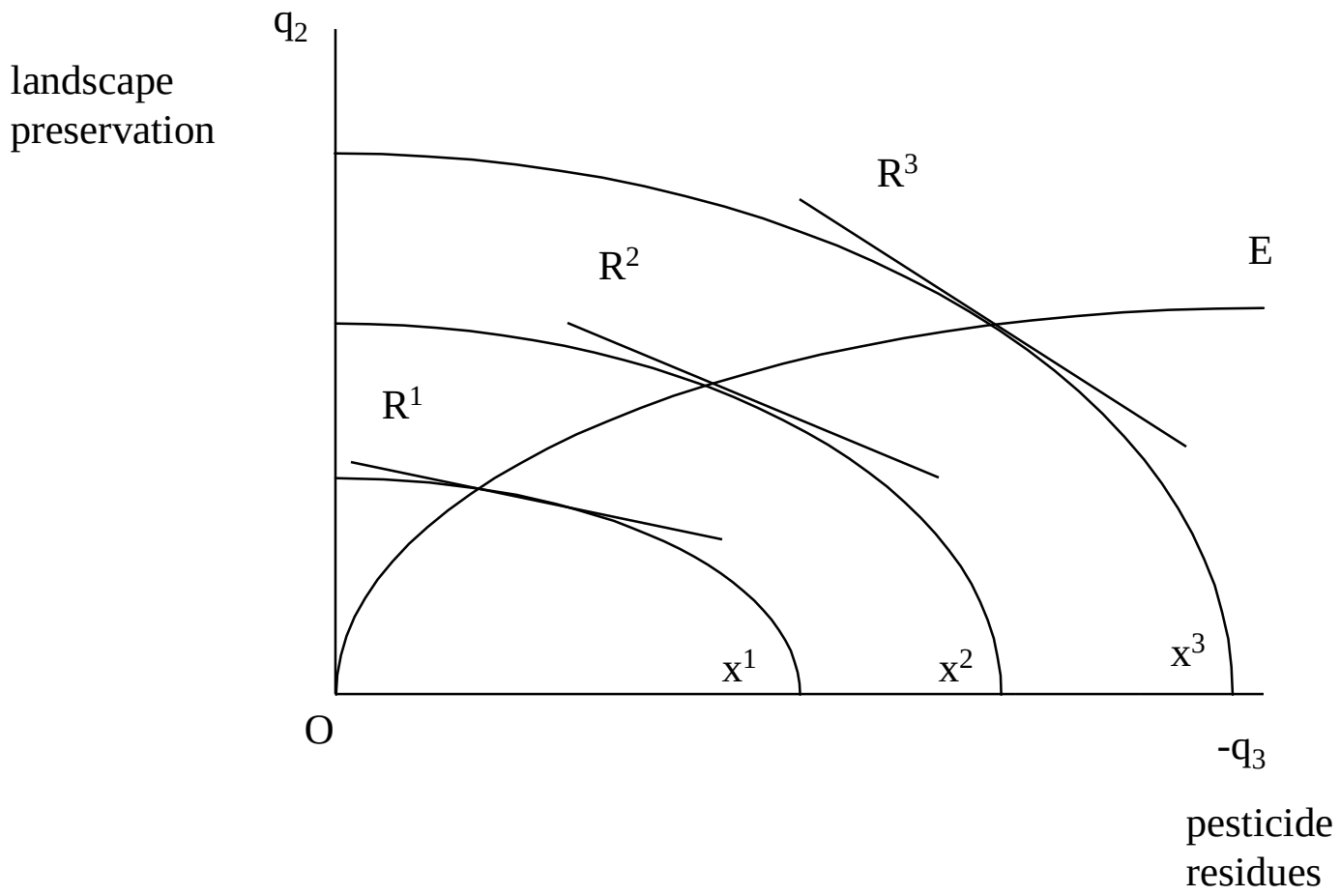

q2
landscape preservation
R3
E
R2
R1
x1
x2
x3
O
q1
farm income support

Figure 6.


q_2
landscape preservation
R^3
R^2
E
R^1
x^1
x^2
x^3
O
$-q_3$
pesticide residues

landscape preservation q_2 but also result in pesticide residues q_3 where q_3 has a negative effect on human or animal welfare, then the function

$$x : x^0 = h\,(q_1; q_2; -q_3)$$

will result in three joint products. Holding q_1 constant, the transformation of countryside preservation q_2 into pesticide residues ($-q_3$) may result in a transformation function in which landscape preservation (q_2) due to agricultural income support (x) can only be achieved with increasing levels of pesticide residues ($-q_3$) (see Figure 6). This captures the fact that negative joint products, or bads, can result in "multidysfunctionality," and that such effects need to be included in any calculation of the impacts of a particular policy choice. The rate of product transformation given by the slope of the "price lines" R^1, R^2, and R^3 in any of the figures above describes the trade-offs of income support for landscape preservation or pesticide residues at increasing levels of agricultural subsidy, and vice versa. Movements from x^3 to x^2 to x^1 would describe the impacts of agricultural subsidy reduction. With this simple basis, analysis can proceed to empirical estimates of these trade-offs.[18]

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[18]Following the empirical literature on multiple output technologies, the flexible functional form developed by Christensen, et. al. (1973), Diewert (1971) and Lau (1978), the translog (transcendental logarithm) function, can express a cost or (dual) profit function, and would allow for estimation of the trade-offs discussed above, assuming accurate measures of joint products were available in relation to levels of agricultural subsidies.

A cost function in translog form is:

$$\ln C = \alpha_0 + \sum_i \alpha_i \ln w_i + \sum_k \beta_k \ln y_k + \tfrac{1}{2} \sum_i \sum_j Y_{ij} \ln w_i \ln w_j$$

$$+ \tfrac{1}{2} \sum_k \sum_l \Theta_{lk} \ln y_1 \cdot \ln y_2 + \sum_{ik} \sum_{ik} \delta_{ik} \ln w_i \ln y_k$$

$$i, j = 1,\ldots,m, \qquad k, l = 1,\ldots,n \qquad (1)$$

where jointness is the norm. Nonjointness requires that $\Theta_{k1} = -B_k B_1$ for $k \neq 1$ (see Nadiri, 1991).

6. A Critique of "Multifunctionality"

The preceding analysis shows that agricultural protection and its converse, agricultural liberalization, may be described as cases in which joint products typically result. Some of these products may be environmental benefits (goods), others are environmental costs (bads). Whether a particular policy increases net welfare depends on the sum of these positive and negative products. Arguments in favor of "multifunctionality" have typically supported maintaining or expanding agricultural subsidies because, notwithstanding distortions to trade, they result in gains not only in farm income, but have joint products such as landscape preservation.

Two main conclusions emerge from the analysis above, the first from the discussion of targets and instruments, the second from the analysis of joint products. Both undercut claims in favor of the multifunctionality of agricultural subsidies. The first is that there are generally more direct routes from policy instruments to environmental targets than agricultural subsidies, which are oblique and likely to be underspecified, and which pose substantial burdens to trade in return for their putative environmental benefits. Using agricultural subsidies to enhance landscape preservation, for example, is less efficient than policies which directly compensate farmers for countryside improvements, without encouraging simultaneous increases in negative externalities, such as pesticide overapplication.

Secondly, a full accounting of the multifunctionality of agricultural subsidies must include both positive and negative joint products (e.g., landscape protection ***and*** pesticide residues). If empirical analysis shows that both are present, arguments in favor of agricultural protection due to one cannot ignore the presence of (and tradeoffs due to) the other. In 1993, for example, Hartmann and Matthews reported that fertilizer use in European Union countries, responding to

high per hectare subsidies in the 1980s, was 275.6 kg/ha in Belgium-Luxembourg, 216.3 kg/ha in Denmark, 263.1 kg/ha in Germany, 185.6 kg/ha in France, 315.6 kg/ha in the Netherlands and 133.9 kg/ha in the United Kingdom, compared with 41.1 kg/ha in the United States. Pesticide applications in the European Union were 3.1 kg/ha in Denmark, 4.1 kg/ha in Germany, 10.2 kg/ha in Greece, 3.2 kg/ha in France, 17.3 kg/ha in Italy, 22.2 kg/ha in the Netherlands and 5.9 kg/ha in the United Kingdom, compared with 1.8 kg/ha in the United States (Hartmann and Matthews, 1993, p. 11).

A recent example of resulting errors in policy prescriptions based on partial analysis may be helpful. Sianesi and Ulph (1998) argue that higher European Union subsidies should be given to conventional crops rather than genetically modified crops which are resistent to various insect pests. They reason that the consequence of adopting insect-resistent crops will be to eliminate many insects on which birds depend, and to seriously threaten the survival of many farmland bird species. Accordingly, subsidies should be paid to non-modified crops "and then should be raised over time so as to choke off the demand for further crop modification" (p. 3). A collateral result of this exercise is that research and development (via the relative price effect) into genetically modified crops will fall.

The irony of this result, which is based on a modelling exercise without empirical support, is that the evidence of bird species losses (prevention of which is the purported environmental target) is drawn from data on pesticide uses on *conventional* crops (Campbell, et. al., 1997). Hence, further subsidization of these crops, unless accompanied by severe restrictions on pesticide use and land conversion generally, would be expected to *aggravate* current bird species losses, not alleviate them. Moreover, the assumption that genetically modified, insect-resistent crops will

lead to the elimination of insect species assumes that these insects have no biological niches other than these crops, which cannot be true in evolutionary terms, since modern cropping is a very recent development. It also assumes that insect resistance will spread across plant species from modified crops to all of the other plants on which these insects depend, a highly debatable conjecture.[19] In fact, since the introduction of herbicide tolerant soybeans and insect resistent corn and cotton in the U.S., where they now account for roughly 40 percent of soybeans, 20 percent of corn and 10 percent of cotton, herbicide and pesticide sales have fallen by about 30 percent on these crops (Hayenga, 1998).

Indeed, the primary challenge to the use of genetically modified crops is not only or even primarily insect elimination, but the same dilemma faced by conventional pesticides used on conventional crops: insect resistance. Decisive steps to manage resistance of genetically modified crops to a wide range of insects has now led Monsanto and Novartis, two key sales agents, to require that as much as 25-50 percent of corn or cotton be retained in conventional cropping so as to preserve non-resistent insect pest populations (Benbrook, 1999, p. 23). It is notable that these requirements do not emerge from subsidies to conventional crops, but from private incentives to

[19]Sianesi and Ulph (1998) acknowledge that the assumption that non-modified cropping technology "entailed no loss of species nor any other form of externalities" is "unrealistic," but that "one may still want to assume that the genetically modified crop has a greater impact on species loss...". They further assert that "The widespread cultivation of modified crops would thus entail a drastic reduction in invertebrates on a much larger scale both spatially and temporally" (p. 25). Rather than "unrealistic," a more accurate term for their assumption is "false." The relative impact of modified and conventional cropping on bird species is still unknown, but evidence from the U.S. establishes as fact that conventional cropping has had devastating impacts on these species (see Sampson and Knopf, 1994; Gerard, 1995; Graber and Graber, 1983). This is also the conclusion of the studies cited by Sianesi and Ulph (1998, p. 2), in which "severe and widespread declines in the breeding populations of many farmland bird species (e.g., Marchant, et. al. 1990; Campbell, et. al., 1997, table 2.1) ... coincide with radical changes in farming practice which includes increases in the sue of agrichemicals to control weed and insect pests."

retain markets for insect resistent varieties.

Drawing on the evidentiary criteria and discussion of joint products above yields several concluding observations on such arguments for multifunctionality. First, defense of agricultural protection in the EU in the name of multifunctional effects, such as the preservation of bird species, fails the first evidentiary test: there is little empirical evidence supporting the claim that the burdens to trade are justified by environmental benefits to bird species. Indeed, the evidence is to the contrary: EU subsidies are associated with widespread loss of bird habitat and populations. Such subsidies are not necessary to the preservation of such species, nor are they primarily aimed at them; they would be better described as aimed against them. Second, when feasible alternatives such as wildlife refuges or habitat protection exist (such as the Conservation Reserve Program in the U.S.) there is evidence of direct effects on protection of bird species (Allen, 1993). The lesser effects on trade of such refuges are accompanied by proportionately greater environmental benefits. Third, agricultural subsidies paid to EU farmers in the name of saving bird species involve highly concentrated benefits to farmers, and highly diffused (if any) environmental damage reductions in the form of species preservation. Far better would be to remove subsidies for conventional crops, and utilize these funds for direct programs of habitat protection and support for alternative cropping methods, such as integrated pest management (IPM) and conservation tillage, both of which have been proven effective in protecting a variety of bird species (see Altieri, 1995; and Ervin, et. al., 1998).

In the final analysis, the multifunctionality of agricultural subsidies turns out to be a highly contrived argument in support of species preservation, because other more feasible instruments are at hand. Moreover, when *all* of the joint products of such subsidies are considered, including

land conversion and pesticide use, the argument quickly becomes one of multi***dys***functionality, and the continued destruction of species and habitat in the name of farm income support.

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