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Policies for Promoting Public Goods in Agriculture

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Abstract

The ongoing negotiations of the World Trade Organization (WTO) on agriculture has triggered an increased interest in the linkages between commodity production and public goods in agriculture. This paper takes a closer look at this issue. Particular emphasis is placed on production economics and policy design issues.

Production is placed in a multi-product multi-input setting. The provision of public goods from agriculture is then analyzed utilizing a principal-agent framework. Particular emphasis is placed on issues pertaining to incentive compatibility, informational aspects and the participation constraint. Public finance aspects of various policies are also addressed. Price supports are of particular interest as they are widely used in European agriculture. This makes analyses of price supports particularly relevant.

Key words: Multi-product production, public goods, agriculture, principal-agent models, resource allocation, policy.

Introduction

In the current round of the WTO negotiations on agriculture, the environmental aspects of agriculture have received considerable attention (Ervin, 1997; Runge, 1998). Countries that currently have pursued agricultural policies with large transfers to farmers or to the agricultural communities, have shown particular concern regarding the effects of trade liberalization on the provision of public goods (see for example Norwegian Ministry of Agriculture, 1998). This has given rise to the term "*Multifunctionality in Agriculture*". It is quite obvious that agriculture has a multifunctional role as agriculture provides several public goods as by-products to its market commodities. Examples of such positive public goods include biodiversity, maintenance of traditional landscapes, wildlife habitats and agriculture's contribution to sustaining rural communities and cultures (Marsh, 1992). Agriculture, however, also creates some negative by-products, including pollution of water courses, ground water and the air from the use of fertilizers and pesticides, soil erosion resulting from unsustainable farming methods, and the loss of biodiversity caused by extensive monocultures, fertilization or pesticide use.

While it is generally accepted that agriculture produces positive and negative public goods, there is controversy related to the importance of these public goods and bads,¹ and what are good policies for providing the desired public goods.

- Major food exporters — like Argentina, Australia, New Zealand and the United States — emphasize that good policies have minor or preferably no distorting effects on food production.

¹ For the remainder of this paper the term *public goods* relates to both positive and negative public goods. Whenever a distinction is needed, this is done explicitly.

- High cost agricultural producers with a strong agricultural lobby – like Austria, Japan, Switzerland and Norway – tend to emphasize that market distortions are of minor importance compared to securing current provision levels of the public goods.

Both these positions are extremes as they do not entail a comparison of the marginal costs of the market distortions in relation to the marginal value of the public goods provided.² A constructive discussion of these issues demands that one has a clear understanding of what characterize public goods (and other goods classifications), and a concise and systematic approach to analyze multi-good production.

To avoid having too many objectives for the agri-environmental policies, I suggest a distinction between the public goods that are site specific and where agriculture may have a unique role compared to public policy goals like the creation of jobs, where other sectors may provide these jobs at lower social costs than agriculture. In addition, I recommend that agrienvironmental policy concentrate on the "everyday landscape" and that special landscapes or management objectives are the responsibilities of separate policies for nature conservancies, national parks etc. This distinction reduces some of the adverse selection and moral hazard aspects that always should be considered in designing policies.

In the next section I present an overview of the theoretical sides of public goods before I discuss some of the theoretical implications of this for policy design. The following section deals with production economics before I proceed to discuss policies for promoting the production of public goods from agriculture. The wide extent of price supports in European agriculture therefore makes it particularly interesting to investigate the effects of price supports as one mean to promote the production of public goods from agriculture.

Theoretical background

Public and private goods

There is much confusion regarding public goods. More specifically there is confusion regarding what classes of goods that are unlikely to be efficiently allocated in markets and those that are not. Randall (1983) is one of the few analytically tractable and systematic approaches to this question. Figure 1 is a slight modification of Randall (1983). The major difference between Randall's classification and mine is that he has discrete demarcations along the two dimensions rivalry and excludability, while I prefer to use continuous scales on excludability and rivalness.

Figure 1 shows that the crucial dimension for efficient allocation by the market is the degree of rivalness as indicated by the jagged line. The more rival a good is, the more likely it becomes that the market is able to provide efficient allocations.³ The primary

² The issue of valuation of non-market goods is not addressed in this paper. A good summary of the discussion of the valuation of public goods – in particular related to contingent valuation – can be found in the *Journal of Economic Perspectives* (1994) in articles by Diamond and Hausman (1994) and Portney (1994). A more institutional oriented critique of contingent valuation can be found in Vatn and Bromley (1994).

³ Other factors that are important for efficient allocation by the market relate to the market power of the various market participants. More specifically, are the market participants likely to display price-taking

reason for this is that the more rival a good is, the likelihood for free riding behavior decreases. This implies that market intervention may be warranted for more types of goods than pure public goods, i.e. for other goods than those that have low degrees of both rivalness and excludability. In such a perspective the term *public goods* is not very precise when it comes to providing a demarcation between situations when policy intervention may be warranted and where the market should be "left to itself".

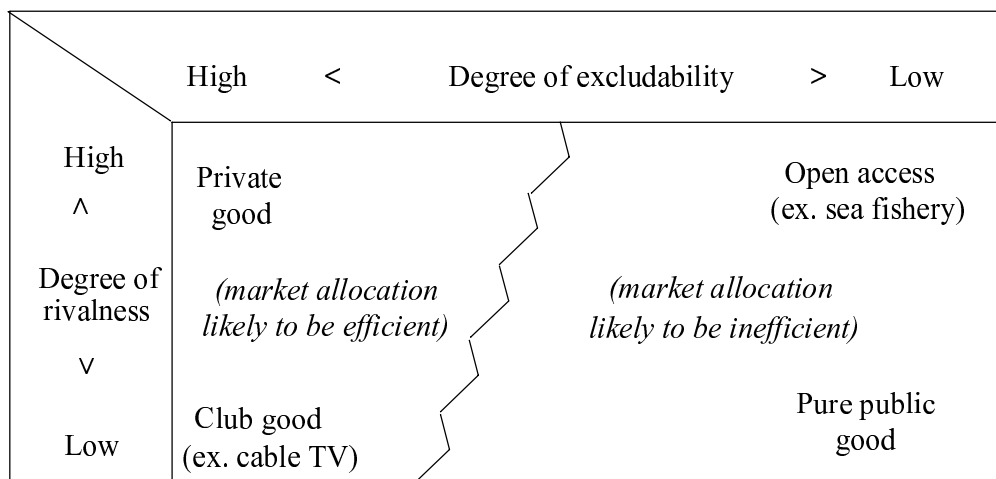


Figure 1: Excludable and rival goods (modified after Randall, 1983).

There is no easy way out of this terminology caveat. This is particularly the case when it comes to agriculture, where its multifunctional character further complicates matters. One escape route is to ask if any of the goods provided display *public good attributes*, i.e., attributes that clearly cannot be efficiently allocated by the market. One implication of such an approach is that it has clear linkages to the concept of externalities. Such a linkage has two major advantages:

- (1) It directly points to the *incentive dimension* of policy – some factors are outside the objective sphere of agents, thereby facilitating a risk that these factors may not be accounted for unless appropriate policies (incentives) are put in place.
- (2) A cost-benefit perspective on policy implies that even if we observe some externality, it may not be worth while to correct it. More specifically, the externality may be *Pareto-irrelevant* (see Dahlman (1979) for a further discussion).

In terms of multifunctional agriculture, the latter point is of particular relevance. Agriculture produces both positive and negative externalities. Due to the information problems in agriculture (for example nonpoint source pollution and its public good attributes – like biodiversity), many externalities from agriculture are likely to be Pareto irrelevant.

Some mechanism design theory⁴

Any economic system or mechanism is a communication process where messages are exchanged between agents. Each agent transmits messages to which other agents respond according to their self-interest. A successful resource allocation mechanism

behavior (see any good book on industrial organization, for example Tirole, 1988).

⁴ This section builds on Romstad, 1998.

(RAM) utilizes this, so that each agent without necessarily understanding the complete process, is induced to cooperate in the determination of a satisfactory bundle of goods and services (Campbell, 1987). As such RAMs are extensions of the principal-agent model. The major implications of the resource allocation mechanism perspective on agri-environmental are that policies need to:

- (a) Meet the *participation constraint*. If this condition is not met, the regulator (the principal) has no guarantee providers (agents) will produce the public goods in question.
- (b) Be *informationally feasible* and *informationally efficient*. A breach of the informational feasibility condition implies that the policy requires more information than what is available. Consequently, the regulator is unable to verify if agents are compliant or not with the policy objectives. The use of informationally inefficient policies means that there exists some other policy that produces the same allocation at lower costs. Hence, by definition informationally inefficient policies cannot result in welfare maximizing outcomes.
- (c) Be *incentive compatible*. If agents are not faced with appropriate incentives, the regulator is not guaranteed that the desired allocation will emerge.

Setting verifiable policy targets is one of the major challenges for agri-environmental policies. It is also quite obvious designing transparent, targeted and tractable agri-environmental policies is difficult. From a legitimacy perspective it may therefore be the case that policy objectives need to be relaxed in order not to become informationally unfeasible or informationally inefficient.

Precision vs. costs

Besides setting verifiable (informationally feasible) policy targets, the benefits and costs associated with relaxing or tightening policy targets should be investigated. A tighter (more precise) target may "look good", but could come at additional costs that exceed the marginal benefits. Figure 2 presents the intuition behind this reasoning.

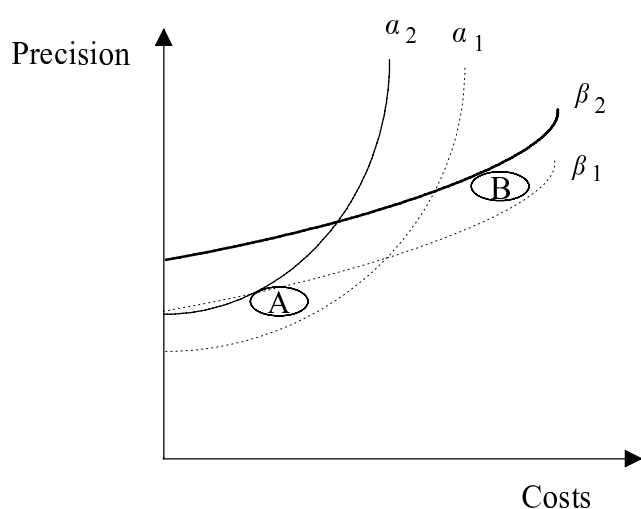


Figure 2: Tradeoff between costs and precision (after Romstad, 1999a)

Consider a situation where there exist multiple other areas in the same region with similar attributes that are not particularly rare. In that case, decision makers may have indif-

ference curves similar to a_1 and a_2 in Figure 2, implying that a less precise and less expensive policy is preferred (A) over the more precise and more expensive policy (B). Next, assume the converse situation, where the area is quite unique in terms of rare attributes. Then decision makers could be willing to spend more money on preserving this area. This corresponds to indifference curves similar to β_1 and β_2 , implying that policy B is preferred over policy A.

Such state contingent differences in policy preferences are quite common. For example, areas that are important habitats for (threatened) species often undergo far stricter management practices than areas with few special characteristics. National parks, nature reserves and landscape management areas are (and should be) managed differently from everyday forest or agricultural landscapes. This does not imply that it is not worth while to try to maintain or enhance the qualities of ordinary landscapes, but that the expenditures for management per hectare of the common landscapes normally would be far below the justifiable expenditures on areas with more special public attributes.⁵

Some production theory

In the conventional definition of production possibility sets, physical input use is assumed constant at the production possibility frontier (Debertin, 1986), which also implies that production costs are kept constant for any allocation of y and z on frontier. In the case of multiproduct - multi-input production, assuming that input use is kept constant is a restrictive assumption. Letting the production possibility frontier be defined by any combination of y and z that does not exceed a given cost is a more flexible approach (Chambers, 1988). This gives the following constrained joint revenue maximization problem:

$$(1) \quad \left\{ \begin{array}{l} \text{Max} \\ y, z \end{array} \right\} p_y y + p_z z \quad \text{s.t. } C(y, z) = \bar{C}$$

when the cost constraint has to be met. This gives the following Lagrangian:

$$(2) \quad \mathcal{L} = p_y y + p_z z + \lambda[\bar{C} - C(y, z)]$$

with the following first order conditions:

$$(3a) \quad \frac{\partial \mathcal{L}}{\partial y} = p_y - \lambda C_y = 0$$

$$(3b) \quad \frac{\partial \mathcal{L}}{\partial z} = p_z - \lambda C_z = 0$$

$$(3c) \quad \frac{\partial \mathcal{L}}{\partial \lambda} = \bar{C} - C(y, z) = 0$$

where C_y and C_z represent the partial derivatives of the joint cost function, $C(y, z)$ with respect to y and z respectively. With standard assumptions on the second order conditions this gives the familiar expression for the (marginal) rate of product transformation between y and z :

⁵ This relates back to a point made in the introduction that special preservation objectives (rare landscapes and habitats) may require more targeted instruments than those that normally would be part of "every day" landscape policies.

$$(4) \quad RPT_{yz} = -\frac{p_y}{p_z}$$

i.e., that the optimal allocation of y and z is determined by their relative prices, p_y and p_z . Note that all joint pairs (y, z) on the production possibility frontier (the product transformation curve) can be achieved with the same costs, \bar{C} . For positive prices on y and z the profit maximizing allocations must then be located on the thick portion of the production possibility frontier.

Naive understandings of equation (4) may lead to serious misinterpretations of price changes. Suppose that the price on y , p_y , is dramatically reduced. This is often interpreted as a movement along the production possibility frontier. From (3a) it follows that the price drop changes the optimal use of y , and thereby also the optimal resource use (costs).

Figure 3 illustrates these effects. In panel A assume that the scalar a is less than one (like one half). This changes the slope of the price line, which using a strict cost constraint yields a shift in the optimal allocation from A to B. However, when costs are not constrained, the production possibility set may shrink, yielding two effects: (i) the substitution effect from A to B, and (ii) the income effect from B to D.

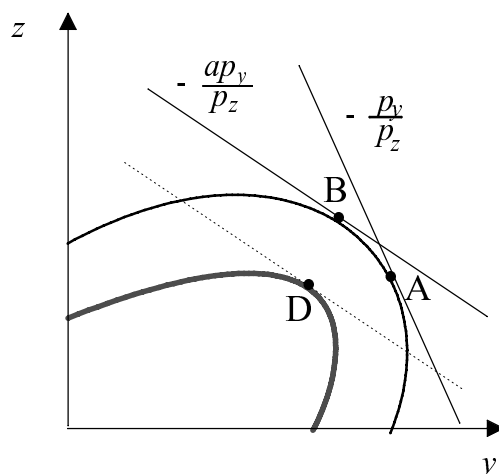


Figure 3: Substitution and income effects when costs are allowed to vary.⁶

In consumer economics one also distinguishes between the substitution and the income effect from price changes when doing demand analysis (Varian, 1984). Generally, the substitution effect is greater than the income effect, but this does not always need to be the case. This is also generally the case on the production side. Two products are technical complements in some region when the marginal cost of producing one product declines when more is produced of the other commodity. For technical complements one cannot analytically sign the total impact of these effects. In terms of policy implications this underscores the need to be careful when signing the effects of price changes on the goods produced.

Russell (1993) indirectly acknowledges these problems when he discusses the effects of agricultural production on environmental services. Pooling several technologies and

⁶ The change in the size of the production possibility set in Figure 4 from the decrease in p_y to ap_y is made large for demonstrative purposes, but it illustrates that when costs are not constrained to a fixed amount, there could be both substitution and income effects.

pooling the technologies, he gets what he calls the *agri-environmental frontier* relationship. It represents the maximum attainable flow of environmental services from agricultural commodity production. Such an approach is useful if one is more concerned with the environmental effects from policy changes than the associated costs. The reason for this is while the standard production possibility requires constant costs along the frontier (or assumes some fixed technology), this may not be the case for the *grand production possibility frontier* (GPF). The *grand production possibility frontier* (GPF) is then found by making an envelope around all the existing production possibility sets. That way, the GPF borders the production possibility sets. There are two ways of viewing the production possibility sets:

- (1) A production possibility frontier is the pair of allocations (y, z) that derived from keeping their respective total costs constant for any movement along the frontier. Note that $C_A \neq C_B \neq C_C$ (in general terms $C_i \neq C_j \forall i$ and j). If this was not the case some of these production possibility sets could be captured by one common production possibility frontier by definition.⁷
- (2) Alternatively, each of the production possibility sets can be viewed as representing the production possibilities arising from using different technologies that require some additional investment compared to the existing technology. Hence, switching from one technology to another is not without costs. This perspective corresponds to the *putty-clay* framework of Johansen (1972).

The GPF has two desirable attributes in illustrating *possible* tradeoffs between y and z :

- (i) The GPF borders the maximum attainable z in terms of y or vice versa, thereby identifying the meta level tradeoffs between y and z .
- (ii) The GPF points to opportunities in utilizing the jointness between y and z .

Compared to the production possibility sets, the GPF does however also suffer from some serious weaknesses, of which I find the following the most important:

- (A) By itself the GPF provides little information on the welfare properties of the various allocations on the frontier as these may have been reached with considerable differences in costs.
- (B) The potential large variations in the costs for various allocations on the GPF do not ensure that agents will choose allocations on the frontier. Thus, even though the GPF captures potential effects of policy, it in no way guarantees that agents will choose allocations on the frontier.
- (C) A problem arising from (b) is that it becomes complicated to predict the effects of policy changes in the GPF framework.

Despite these shortcomings, the GPF framework can be useful. Instead of pooling production possibility areas with extremely different costs, one can restrict the GPF by constructing it from production possibility sets that are not too different in underlying costs or from production possibility sets that can be constructed when costs do not exceed a certain level.

⁷ Others who have used this approach to model the connections between agricultural commodity production and the provisioning of public goods include Runge (1999).

An important joint feature from both the GPF and production possibility frameworks is that they underscore that in many cases there may not be a one-to-one relationship between the production of the various private and public goods, input use and technology.⁸ To illustrate this, consider Figure 4 with three scenarios for the production of one public good, z_i where $i \in \{a, b, c\}$ and one private good, y . All these scenarios assume that there is no payment for providing z . Let y^* denote the profit maximizing production level of the private good y in absence of any payment for the public good, z_i , $i \in \{a, b, c\}$ and for a given cost constraint. The three interior thin and solid lines represent the frontiers of the respective profit maximizing production possibility sets, and y^* represents the corresponding profit maximizing output level for the private good. The outer thicker solid lines represent the GPF, while the shaded regions are the probability distribution over the provision of z given y^* . Reasons for such a spread in the provision level of z include variations in local conditions, farmers' attitudes, etc. These are factors not captured in the model from which the production possibility sets are derived.

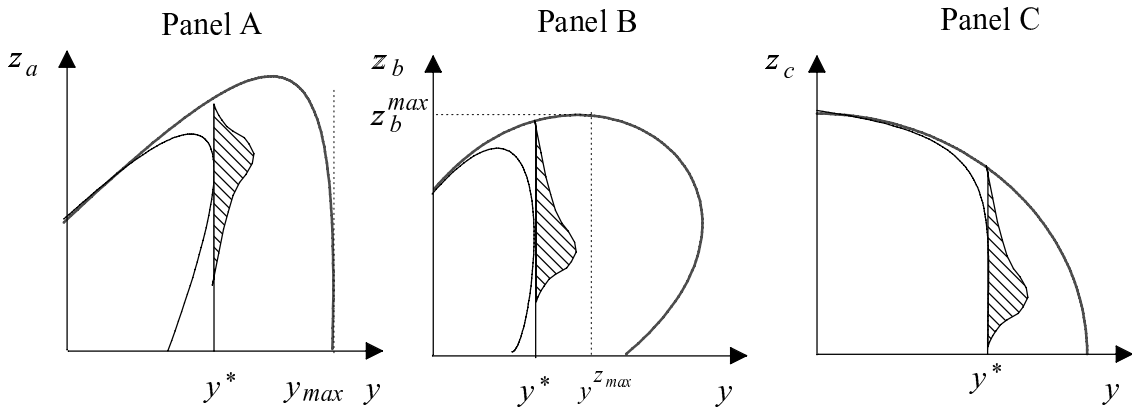


Figure 4: GPFs and profit maximizing production possibility areas.

- (A) Panel A depicts a situation where the frontier is everywhere increasing in z_a until some maximum value of y , y_{max} , indicating that the more one produces of the private good, the larger the potential becomes for providing z_a .
- (B) In panel C the converse situation is illustrated – as the production of the private good increases, the potential for producing the public good decreases.
- (C) Panel B is a combination of panels A and C, where the potential for producing the public good increases for commodity production levels up to $y^{z_{max}}$, and decreases for commodity production beyond that level.

Note that none of the observed allocations are on the GPF. This does not imply that farmers have chosen privately sub-optimal allocations, but that the prices do not support allocations at the GPF.⁹ Also note that when there is no price on z (i.e. $p_z = 0$) there is no incentives for producing z beyond the level where it positively affects the output of the private good, y , (panels A and B) or has no negative impact on private good production (panel C).

⁸ Many papers on the production of public goods apply a functional relationship between the production levels for private and public goods (see for example Buckwell, 1989; Howitt, 1995).

⁹ This corresponds to the standard result in production economic theory that it is extremely rare that attaining the maximum production level will be consistent with profit maximization.

Policy implications

This section deals with policy instruments for the "every day agricultural landscape". There is no principal difference in producing public good attributes and private goods. Assume that the joint cost function $C_\theta(y, z)$ exhibit the standard properties. Expressed in the dual formulation, the agent's profit function per hectare may exhibit the following elements:

$$(5) \quad \left\{ \begin{array}{l} \text{Max} \\ \mathbf{y}, \mathbf{z}, \theta \end{array} \right\} \pi = (1 + \Delta) \mathbf{p}_y \mathbf{y} + \mathbf{p}_z \mathbf{z} + \mathbf{p}_z \tilde{\mathbf{z}} - C_\theta(\mathbf{y}, \mathbf{z}) + a + LS$$

where

- Δ denotes a price subsidy,
- \mathbf{p}_y denotes a vector of commodity market prices,
- \mathbf{y} denotes a vector of market (private) commodities,
- \mathbf{p}_z denotes a vector of direct payments for public good attributes,
- \mathbf{z} denotes a vector of public good attributes,
- \mathbf{p}_z denotes a vector of indicator based payments,
- $\tilde{\mathbf{z}}$ denotes a vector of indicators over public good attributes,
- C_θ denotes a cost function for technology θ ,
- a denotes a per hectare area payment, and
- LS denotes a lump sum transfer.

The main point of equation (5) is to show that policy makers have a wide array of potential instruments at hand when designing an agri-environmental policy. The next subsections deal with the principal advantages and disadvantages of these instruments.

Price supports

Price supports, $\Delta > 0$, imply that the farmers receive more for their agricultural commodities than the market price. Generally, price supports have two undesirable properties:

- They lead to increased intensity (fertilizer, pesticide and labor use) than the market by itself would indicate. Consequently, there will be a net social loss as the marginal costs of production will exceed the social value of the marginal product.
- Increased fertilizer and pesticide use may increase overall pollution from agriculture.

Despite these undesirable properties, such price supports could be part of an efficient agri-environmental policy. Suppose that the relationship between a private commodity, y , and some public good attribute, z_1 , is of the form depicted in panel A of Figure 4. Provided that there are large transaction costs associated with observing the public good attribute and that the standard deviation of the probability distribution is small and the probability distribution is skewed towards the frontier, a correctly set price support could increase the provision level of z_1 . In that case it would meet the necessary RAM criteria (participation, informational viability and efficiency and incentive compatibility). There are, however, three general potential caveats from such a policy.

- (1) It may not lead to any significant increase in the provision level of the public good attribute for two reasons:
 - (a) The price support on the private commodity provides no incentives for increasing the production of the public good attribute. Any increase in the provision

levels of the public good attribute would be by-product of the increase of the private commodity, and it would depend on how the distribution of the public good attribute changes with increased levels of the private good.

- (b) Even though a price support has an "income effect" (an outward shift in the production possibility set), the risk is large that the substitution effect from the price support may reduce the provision levels of the public good attribute.
- (2) It could increase the quantity of y beyond the social optimum. This problem may be reduced if consumer prices are set in the market. A supply increase will then lead to a drop in the market price until equilibrium in the commodity market is restored.
- (3) Suppose that there is some other public good, z_2 , that also is closely linked to the production level of y , but that this relationship is of type C in Figure 4. This could imply that less of the second public good attribute would be provided. The overall welfare implication of these changes depends on the relative values and magnitudes of the change in the provision levels for the two public goods in hand.

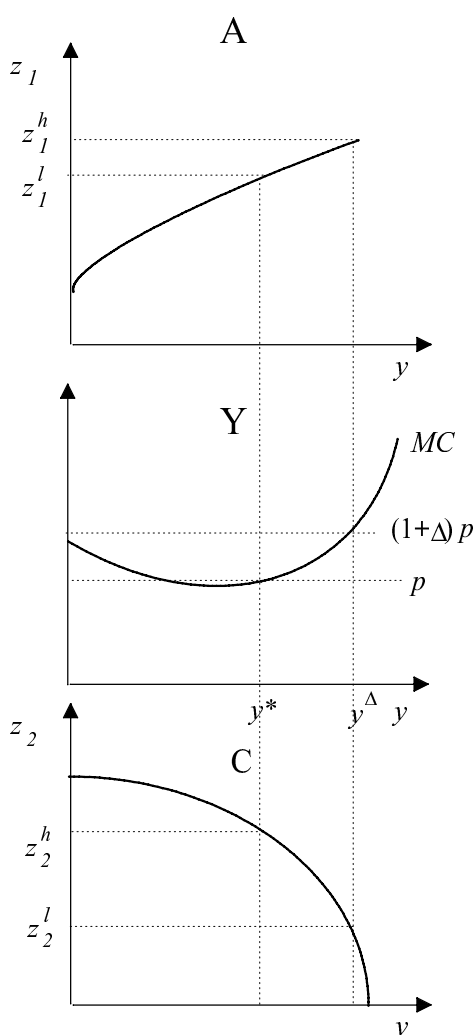


Figure 5:
 Intended and unintended effects on the provision of public goods from a commodity price increase.

Figure 5 depicts a situation where a price support, Δ , is given. For simplicity, only the GPF of the production possibility sets are used in the analyses in panels A and C. The interaction between panel Y and panel A in the figure illustrates what goes on. The increase in the product price from p to $(1+\Delta)p$ leads to an increase in the production of y from y^* to y^Δ , thereby indirectly increasing the production of z_1 from z_1^l to z_1^h . An unintended side-effect of the price increase on the private commodity, y , is a decline in the production of z_2 from z_2^h to z_2^l .

Figure 5 depicts one reason why care is needed when using commodity price supports to influence the provision levels of public good attributes. Generally, such effects will be present. A primary example of this is how increased production per hectare often leads to more use of fertilizers and pesticides, thereby rising the risk of pollution from agriculture.

The problem illustrated in Figure 5 primarily stems from applying a functional relationship between the production of the market commodity, y , and the public good attributes, z_1 and z_2 , i.e. wrongfully assuming that there is a one-to-one relationship between private and public goods production. Moreover, it provides an illustration of Tinbergen's (1950) famous result that in general one needs one instrument per objective to be achieved.

Direct payments for production of public good attributes

One of the nice features of payments on the public goods provided is that they provide direct incentives for the production of the public good. This is particularly important if the relationship between goods and attributes is better described by a production possibility area, rather than through a functional ("dose-response") relationship, or if production possibility sets can be perceived as achievable with additional investments (i.e., the "putty-clay" framework of Johansen, 1972).

The feasibility of direct payments depends crucially on the observability of the public good. Using the RAM terminology, this corresponds to informational feasibility. However, for the allocation resulting from a direct payment to be a candidate for welfare maximization, the same allocation cannot be achieved at lower informational costs. If this is not the case, direct payments constitute an informationally inefficient policy.

Suppose that no other policy achieves the same allocation or an allocation with more of the public good attribute. In a strict sense, direct payments then become informationally efficient. This does, however, not imply that the policy per se meets the welfare criteria. Utilizing the previous reasoning on costs and precision, one also needs to compare the marginal benefits and costs of various policies. Provided that precision is not overwhelmingly important and the informational costs are high, it is very likely that payment through some indicator or other production factor that is closely linked to the provision level of the public good will be more consistent with the objective of maximizing social welfare.

Other policy options

Alternate policy instruments for promoting public goods include input regulations, lump sum transfers and cross compliance payments. The difficulty with these and other policy instruments are that they do not provide direct incentives for producing public goods. Hence, unless care is taken in the design of such policies, undesirable allocations may result.

Still, from a theoretical perspective cross compliance has some interesting properties. Those who voluntarily subject themselves to a cross compliance scheme do so because their expected profits from participating exceeds the expected profits from not doing so. Conversely, if the expected profits from non-participation exceed the profits from participation, the farmer chooses not to participate. This implies that the farmers with the least costs of complying with the regulations are more likely to sign up. The result is some sort of menu based system that could yield separating equilibria. Under certain conditions separating equilibria are welfare enhancing (see Rotchild and Stiglitz (1976) for an overview). In particular, note the condition that for separating equilibria to be sustainable, there can be no more than one principal.

Consequently, cross compliance may be a cost reducing strategy to meet certain policy targets. As cross compliance programs can be easily tailored to specific regional needs, or made to induce that a minimum level of some public good attributes is provided, they are flexible and targeted. In a way specifically tailored cross compliance programs fall on the borderline between policies for the everyday landscapes and landscape preserves, utilizing contracts. This opens up for a wide array of policy options, including auctions

to make farmers provide the desired public goods at the least costs. One potential disadvantage with such schemes is that the transaction costs may exceed the gains from having the least cost providers sign up.

Practical policies for public good production

One problem in applying the production possibility set approach is that there is insufficient data to estimate the various frontiers. Current data are relatively sparse, only indicating partial relationships. Still, preliminary data suggest some partial relationships that are of interest related to some public good attributes as illustrated in Table 1.

Table 1: Some key partial relationships (preliminary)

Physical measure	Public good attribute				
	Bio-diversity	Open space	Access/recreation	Cultural heritage	Reduced pollution
Production intensity	–	o	–	+/-	–
Increased acreage	+	+	(–)	+	(–)
Land use (border zones)	++	+	+	+	+

One striking feature from the table is that increased production intensity (that for example could be brought about from price supports or some input subsidies) generally does not appear to have any positive effects. This finding is consistent with the theoretical findings using a production possibility approach. Table 2 shows the RAM criteria for policies that could induce some of the desired physical measures from Table 1:

Table 2: Evaluation of some policy options^(a)

Policy criterion	Policy			
	Environmental payments	Land use/border payments	Acreage payments	Input subsidies
Informational aspects	–	+	+	+
Participation constraint	+	+	+	+
Incentive compatibility	+	+	?	–
Objective achievement ^(b)	++	+	+/-	–
WTO-legal	+	+	+/-	+/-

Remarks: (a) Cross compliance schemes are not evaluated as their design is highly variable.

(b) In terms of meeting physical objectives in top row of Table 1.

Tables 1 and 2 are not conclusive. Rather they illustrate some likely features of various physical measures and related possible instruments for promoting the production of some important public good attributes. Of particular interest is the preliminary evaluation of environmental payments, where the informational aspects, in particular the costs of processing information, currently pose difficulties. Biological diversity is one example of an environmental attribute where there are concerns about the informational costs.

From a practical perspective *land use and border payments* come across as an interesting option. Although such payments do not ensure the achievement of all objectives, it is a close proxy. Through remote sensing its monitoring costs are also likely to be reasonable, even in the short run. Flat rate acreage payments and input subsidies are more troublesome, both in terms of reaching the public good attribute objectives and in

being incentive compatible.

Special problems in marginal farm areas

Marginal farming areas are recognized by having higher production costs for the agricultural commodities in question. This recognition is not new, but dates back to Ricardo and his derivation of the (Ricardian land) rent concept. Variability in the conditions for farming raises some interesting problems, in particular related to the ongoing discussions on liberalization of world trade in agricultural commodities:

- (a) There is a concern that restrictions in agricultural support schemes will render farming unprofitable in large marginal farming, with a consequent loss of important public good values (Sumelius, 1997; Norwegian Ministry of Agriculture, 1998).
- (b) Policies aimed at maintaining the provision levels of public good attributes need to take account of varying conditions to ensure sufficient incentives for continued agricultural production if that is essential for the public good attributes in question.
- (c) Implicit from (b) is the problem of asymmetric information and the possibilities for information rent captures, i.e. that the resulting agri-environmental policy to sustain the production of public good attributes becomes more costly than it needs to be.

Point (a) in the above list is at the core of the problem. Provided that some agriculture is needed for the production of at least some of the public goods at hand, one needs to make sure that the participation constraints are met. The short participation constraint is that the marginal costs of producing y should be less than or equal to the commodity price. Here one encounters problems of how to calculate the marginal costs of producing y , in particular when there exists some payment on z . Two options exist:

$$(6a) \quad (1 + \Delta) p_y \geq MC(y^*)$$

$$(6b) \quad (1 + \Delta) p_y \geq MC(y^* | z)$$

In (6a) one overstates the marginal costs as this formulation in the case of any positive feedback on the private good from the production of the public good, and understates the marginal costs in case of negative feedback. (6b) is theoretically more correct, but here one runs into another problem when there are multiple public goods, namely in which order to account for the public goods. Whenever these relationships are nonlinear, the order for which one takes account for the public good attributes change the estimate of the marginal costs. The parallel to the integrability problem in consumer economics (Deaton and Muellbauer, 1980) is clear.

The long term criterion for continuing in farming (participation constraint) is that the profits exceed the farmer's reservation wage or profits, i.e. $\pi(\mathbf{y}^*, \mathbf{z}^*) \geq \pi$. This is quite obvious, and should be a matter of concern whenever agricultural production is necessary for the provision of public goods. If the short term condition is met, but the long term participation constraint is not met, lump sum transfers are convenient. However, in term of policy objective fulfillment, lump sum transfers do not contribute on the margin. In such cases it is therefore worth while to investigate if the long term constraint can be met by using more of some of the policy instruments that move allocations in the desired

direction.

The removal of agricultural supports, and in particular the price supports due to its implications on the short term participation constraint, implies that the costs defining the old production possibility set (A in Figure 6) no longer can be defended. Instead, a new production possibility set is defined based on the new prices (B). Moreover, let E define another production possibility set that is sustained based on a decline in the product price, p_y , and an increase in p_z , the direct payments for environmental attributes.

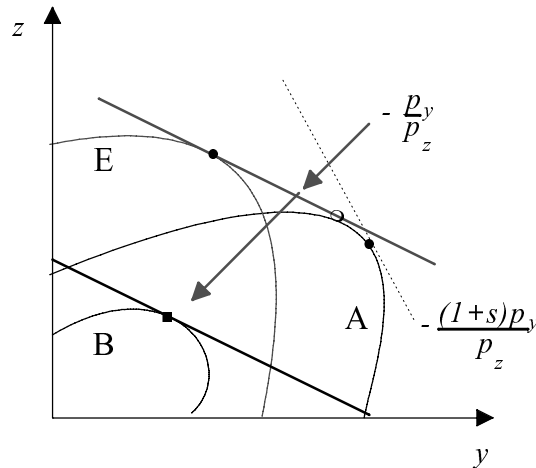


Figure 6: Implications of the removal of agricultural supports with increased (E) and without increased compensatory supports for the drop in the commodity price (B).

A removal of the price supports in Figure 6 (s in the price line $-\frac{(1+s)p_y}{p_z}$) reduces the relative slope of the price line. A naive interpretation of production possibility sets that would imply that more environment should be produced on production possibility set A , i.e. an allocation in the point marked \circ on the frontier of A . However, with the decline in overall income from the removal of the product price support this production possibility set no longer meets the participation constraint. The production possibility set marked B is, however, feasible, and the new allocation, \blacksquare , represents a significant drop in the production of both the private and the public good.

This result should not mislead us to believe that large reductions in price supports are undesirable. A change in the relative prices in favor of the public good, z , coupled with an increase in some other payments satisfy the participation constraint on E , leads to an allocation with a marked increase in the provision of the public good, and some decline in the production of the private good.¹⁰

Buckwell (1989) reaches a similar conclusion – a decline in product prices or other supports without some offsetting policy may cause rapid deterioration of agriculture and its associated public goods. Some empirical evidence suggests such developments from one sided reductions in agricultural supports. For example in Sweden, agricultural policies were changed in the late 1980s with the effect that farm land in marginal areas was abandoned, left to be covered with shrubs or planted with spruce.

¹⁰The results from graphical analysis in Figure 9 partly stem from the way the production possibility sets are drawn in relation to each other. From the definition of production possibility sets it is implicit that failure to meet the participation constraint may have large and undesirable effects.

Concluding remarks

The primary result of this paper is that policies for promoting the production of public goods should be directly linked to the public goods in question. This result hinges on the assumption that the information costs of such direct payments are not too large. If that is the case, payments through some easily observable indicator is the second best alternative. Rarely, optimal policies contain the use of commodity price subsidies. The most important reason for this is that price supports lead to substitution effects in favor of the private good and away from the public good. Only in special cases will the income effect more than offset this substitution effect. Even in these (rare) cases one may ask if paying directly for the public goods would entail less costly solutions as the income and substitution effect then work in the same direction.

The next round of the World Trade Organization negotiations on agriculture may pose particular challenges for the production of public goods from agriculture as commodity prices may become so low that the short term participation criterion (prices exceed marginal production costs) for farming is not met. This is of special concern if the existence of agriculture is crucial for the production of these public goods. In these cases differentiated price supports may be justifiable. One of the major concerns related to the use of price supports is their distortive effects in secondary markets. By making these subsidies pure, i.e., by having different product prices to farmers and the food processing industry, the majority of these distortions can be eliminated.

The argument against pure commodity price subsidies to meet the short term participation constraint is that they increase public expenses. Whenever the *marginal costs of public funds* exceed one, there exists a potential tradeoff between the distortions in the secondary markets and the tax distortions. In marginal farming areas at least parts of these price subsidies may therefore come in the form of import tariffs.

This result has important implications for the overall design of policy instruments to ensure the production of public goods from agriculture. Any public payment for public goods will lead to tax distortions. By equivalence to the above tax wedge argument for some tariffs in marginal farming areas, a second best optimal policy may in general seek to cover some of these public expenses through import tariffs on agricultural commodities. In principle, these import tariffs should be set so that the marginal benefits from reduced public expenditures equal their marginal costs. These costs include changes in allocations between public and private goods, increased pollution caused by higher product prices, and the distortions in the secondary markets.

Finally, this paper illustrates the importance of defining production possibility sets in economic terms, i.e., dependent upon relative price and costs. This has profound implications for policy analysis.

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