MULTIFUNCTIONALITY AND NON-AGRICULTURAL SUPPLY OF PUBLIC GOODS

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ABSTRACT

When public goods are joint outputs of agricultural production, there is a trade-off between agricultural and non-agricultural provision of the public good. The principle of minimal price distortion in the reform of agricultural policies has led to a theoretical recommendation that public goods, if under-provided at agricultural free market level, should be promoted through non agricultural policies instead of agricultural policies. We show that the economies of scope between the agricultural production and the joint public good play a key role in determining the optimal way of providing this latter. If the policy designed is a non-agricultural policy, the production cost of the public good is higher than with an agricultural policy. If the policy designed is an agricultural policy, the production cost is lower but generates market effects. Under the assumption of strictly positive economies of scope, we show that the optimal policy is a mix of agricultural and non-agricultural policy. We confirm this result in the two-country case, demonstrating the optimal level of agricultural support for public good provision is strictly positive and lower than in the case of one country.

Keywords: multifunctionality, jointness, coupled support, protectionism, public good

INTRODUCTION

Consistently with OECD (2000), multifunctionality of agriculture is defined in this paper as the set of public goods produced jointly with a commodity output. In those areas where a particular type of agriculture is multifunctional, a key role for public policy is to ensure optimal provision of public goods. Nevertheless, there can exist alternative ways to provide them, through non farm land management services for instance. According to OCDE (2000), agricultural support is not justified in these cases where it is possible to produce the public good out of the agricultural sector. Thus, the separation of commodity supply and public good supply is the most efficient way to address the issue of public goods in rural areas. We argue that the technological possibility for a separate production is not a sufficient condition for the superiority of the non agricultural supply of the public good. The case where agriculture would be more performing than the non-agricultural sector in providing public goods can arise from economies of scope between agriculture and public goods that can be a source of increased efficiency. The optimal share of agricultural provision and non agricultural provision of a public good depends on these economies of scope, and on the cost of the non agricultural policy for this public good. For this reason we consider two different policies: (i) a direct payment proportional to the farmer's contribution to a public good, (ii) a subsidy of the agricultural production generating a positive externality. There exist some technological conditions where both policies are more efficient than a non agricultural supply of the public good.

some conditions when a joint production is more efficient than a separate production. Then we compare welfare effects of a non-agricultural supply of the public good at constant marginal cost and of a farm output subsidy. In the most general case, we demonstrate that the optimal policy is a mix of non agricultural provision and a farm subsidy. Finally we extend this last result to the two-country cases.

AGRICULTURAL AND NON-AGRICULTURAL SUPPLY OF A PUBLIC GOOD

Case (1): Optimal provision of a joint public good

The concept of jointness is used here to describe the relationship between an agricultural output *y* and a public good *z,* standing for the positive farmers' contribution to land management (biodiversity conservation, landscape, etc.).

Following Sakai's dual definition of jointness (1974), we assume economies of scope between the public good and the agricultural production. Referring to the standard definition of economies of scope in the multi-commodities case (see Dupraz, 1996), we define economies of scope between *y* and *z* as the cost gains achieved when a same vector of output *y* is produced within one production unit instead of two :

$$E(y,z) = C^{m}(y) + C^{m}(z) - C(y,z) \tag{1}$$

where $C(y,z)$ is the multi-output cost function of *y* and *z*, $C^{m}(y)$ is the mono-output cost function of *y* and $C^{m}(z)$ is the mono-output cost function of *z*.

We impose the following hypotheses on the technology, arising from the assumption of marginally decreasing economies of scope:

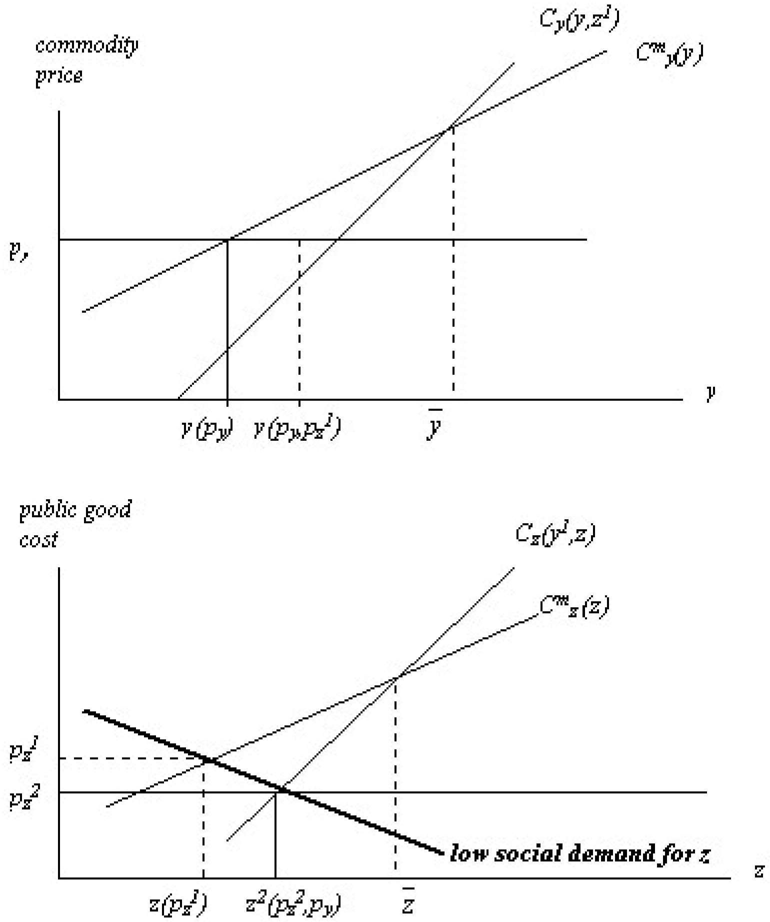
At any level of agricultural production *y*, we consider two cases:

- for low levels of public good provision $z \leq \bar{z}$, economies of scope are positive and marginally decreasing, the jointness between *z* and *y* respects Sakai's main condition for jointness between outputs $C_{yz} = C_{zy} \leq 0$.
  This means that *z* and *y* are complements.
  $E(y,z) \geq 0$, $E_z \geq 0$, $E_y \geq 0$; $E_{zy}=E_{yz} \geq 0$, $E_{zz} \leq 0$, $E_{yy} \leq 0$, which arises from the cost function convexity.
- for higher levels of public good provision $z \leq \bar{z}$, *z* and *y* become substitutes, $C_{yz}= C_{zy} \geq 0$, thus
  $E_z \leq 0$, $E_y \geq 0$; $E_{zy}=E_{yz} \leq 0$, $E_{zz} \leq 0$, $E_{yy} \leq 0$,

This can be interpreted by the fact that when production increases, allocatable factors, such as labor or land, tend to become fixed factors, and the likeliness for economies of scope decreases (Moschini, 1989).
Note that the maximum level of public good provision $\bar{z}$ for having positive economies of scope between agriculture and the public good depends on the level of commodity production. We write $\bar{z}(y)$ this level. As the cost function is symmetric in *y* and *z*, we write $\bar{y}(z)$ the maximal level of commodity production for having positive economies of scope.

We consider the case of suckler cow breeding on permanent prairie, generating ecological conditions favourable to the preservation of some elements of biodiversity, through the development of vegetable species of ecological interest, while grassland provides suckler cows with fodder (Plantureux, 1996). Vegetal biodiversity from extensive breeding is considered as a local public good after Samuelson's definition of non-rivalry and non-excludability. We assume that willingness to pay exists among taxpayers for this public good. Environmental services associated to suckler cow breeding on permanent prairie are probably more important than this element of biodiversity, but we focus on it for its clarity. Economies of scope between agricultural production and biodiversity are assumed positive, which concerns only areas where the productivity in terms of beef and the productivity in terms of biodiversity are not too high, so that $z < \bar{z}(y)$, and $y < \bar{y}(z)$. Plantureux showed indeed that above a certain level of intensification, beef breeding has a negative impact on biodiversity, consistently with the assumption (ii).

Economies of scope can arise from the fact that the land is a non allocatable factor between beef production and grassland biodiversity. It is therefore cheaper for a breeder to produce this type of biodiversity than it is for a non-breeder.



Graph 1. Multi-output cost function C versus mono-output cost function C^m

Result 1
Under the above assumptions, there exist a level of productivity $\bar{y}$ below which the joint production of commodity and public good is more efficient than the separate production of the two. The optimal policy in this case is a pricing of farmers' contribution to environment at a lower rate (p_z^2) than the optimal pricing for non farmers (p_z^1), and the quantity of the public good will be higher. The commodity production will also increase.

On the contrary, above this level of productivity, the non-joint production is more efficient.

Case (2): optimal provision of a public good produced as an externality of agriculture
We consider the case where the public good is an externality of the agricultural output *y*. We shall write *x(y)* the level of public good achieved through agricultural output *y,* such as the prevention of erosion in desertificating areas. This case has been widely analysed and a major conclusion is that the social cost of agricultural production is lower than private cost and the optimal policy is generally a pigouvian like subsidy on the commodity to correct this domestic divergence between social and private cost (see for instance Corden, 1997).

Nevertheless, it is not clear if such a subsidy should coexist with a non agricultural way of producing this public good if it exists, which could be considered as a more targeted policy.

When there is neither agricultural nor environmental policies, the public good *x* now derives from producer maximisation behaviour for the production of the tradable output *y*. *x* does not interfere with farmer's choices, and is completely determined by the level of output and inputs market prices (y^*, $x(y^*)$).

Following Oecd (2000), we represent on graph 1 the effects of a subsidy s per unit of beef on biodiversity.

We write y^s the total amount of beef supplied with the subsidy s and x^s the level of biodiversity achieved then.
The subsidy s has two simultaneous and opposite effects. It raises residents utility of a marginally decreasing amount (HI is the marginal gain), while costing a marginally increasing amount on the beef market (BC = s is the marginal cost). Let L(y) be this total cost, equivalent to ABC triangle. We have L(y*)=0 and L'(y^s)=BC. Consequently, there exists an optimal subsidy on beef is such as BC = HI.

To deduce the optimal subsidy level s°, we formalise L(y) as a function of x on the lower part of graph 2. We write $L(y) = W(x)$, hence

$$L'(y) = W'(x) \cdot \frac{dx}{dy} \quad (2)$$

W'(x) is the marginal cost the public good. Optimum is reached when $W'(x)$ equalises the marginal willingness to pay of the public good HI. Beyond this point, the loss incurred on beef market is greater than the marginal gain of biodiversity. The optimal subsidy s° is such as :

$$W'(x \quad) = HI \quad (3)$$

We assume now that there exists a possible supply of the public good out of the agricultural sector, at a constant marginal cost $g(x)$. This public good *can* be and is *not necessarily* produced as an externality to the agricultural production. Let us consider then an environmental – viz non-agricultural - policy targeted on the public good and no agricultural policy at all. The commodity market equilibrium is left unchanged y^* while public good production is efficient x_e. Non-agricultural supply of the public good generates the amount x_e - x^* of public good. The agricultural sector supplies x^* for free.

Welfare gains from the environmental policy are GNK. One cannot assert that environmental policy is systematically more efficient than agricultural policy. The environmental policy goes further in satisfying demand for public good. It does not induce any losses on the commodity market. But it does not make society benefit fully from economies linked to the positive externality, when $W'(x) < g(x)$.

It is possible indeed to achieve greater efficiency by combining non-agricultural policy and agricultural policy. Then optimal agricultural subsidy then is no more equal to resident's marginal utility, but equal to the marginal cost of public good production out of the agricultural sector.

Agricultural supply of public good is socially less costly than non-agricultural supply until this optimal level. As long as $0<g(x)<HI$, viz. the non agricultural marginal cost of public good is lower than the marginal cost induced by agricultural policy for an output y^s , then optimum at national level requires a strictly positive subsidy, although lower than if no alternative way to provide the public good exists.
The value of optimal agricultural subsidy s' is given by the equilibrium condition :

$$W'(x) = g(x) \quad (4)$$

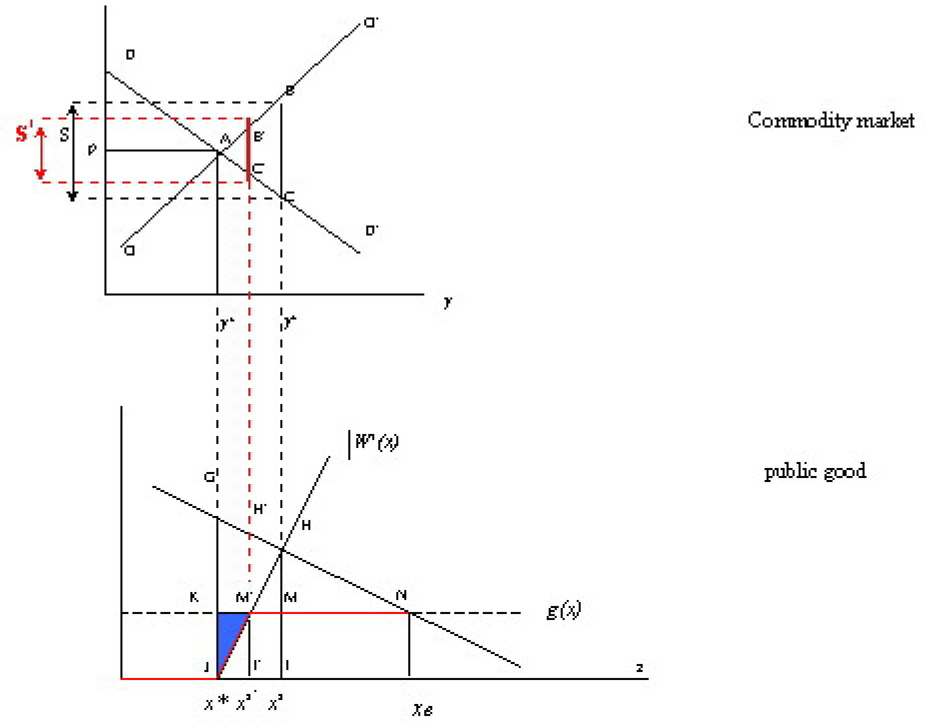
Following (3) :

$$L'(y \quad) = W'(x \quad) \cdot \frac{dx}{dy}$$

We deduce S' such as :

$$L'(y) = g(x) \cdot \frac{dx}{dy} \quad (5)$$

Public good supplied with by the agricultural sector is then $x^{s'}$, while (x_e - $x^{s'}$) is produced by the non-agricultural sector.



Graph 2. production subsidy versus non farm policy.

Without agricultural policy, welfare gains of non-agricultural supply of public good are GNK.
With coupled support and without non-agricultural sector, welfare gains are GHJ.
With coupled support combined with public good supply out of the agricultural sector, total welfare gains are GNM'J, greater than GNK.

Result 2
When a public good is an externality of an agricultural commodity, and when a non-agricultural supply of this public good is made possible at a marginally constant cost, the optimal policy is a combination of a production subsidy and the non agricultural policy. At the optimum, the agricultural subsidy equals the non-agricultural marginal production cost of the public good.

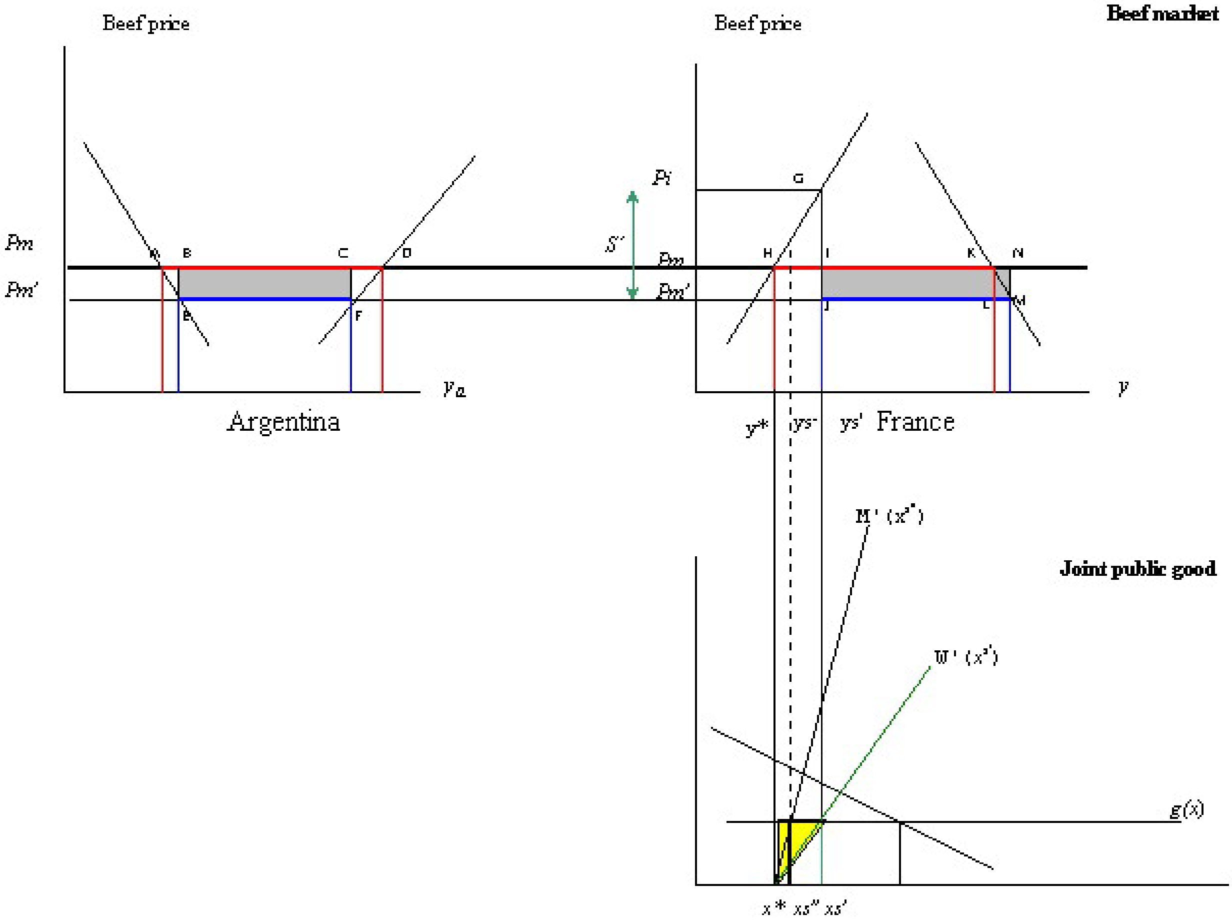
Extra-territorial impacts of domestic policies for a joint public good
We assess in this section the changes induced by the above described policies on trade for large countries. We consider beef trade between two countries, France (importer) and Argentina (exporter). To describe the problematic of multifunctionality, we assume that there exists a local demand in France for some public goods that can be provided either through beef production or through alternative policies. We assume marginal production costs for beef to be lower in Argentina than in France, beef quality to be the same in the two countries, and to simplify, we assume further the local demand for multifunctionality in Argentina to be zero.

Policy options to supply the public good are those considered in section 2.

- The French government finances completely the supply of *x* out of the agricultural sector and incurs losses due to the externality not being internalised. In this case, impacts on agricultural production in France and Argentina are nil. This policy, although generating no distortion on beef market, is not the optimal national policy : welfare losses are registered (yellow triangle on graph 3) compared to the situation of an optimal coupled support combined with an environmental policy.
- The French government sets an optimal subsidy in order to benefit from the externality. Although optimal at the national level, such a policy is not accepted in the green box of the Agreement on Agriculture of the World Trade Organisation. Indeed (graph 3), such a subsidy increases the market share of French beef, and improve French terms of trade at the expense of Argentina, as long as the France is a large beef importer (see Corden 1997 ; Bagwell and Staiger, 1999).

Let J(y) be the international cost of the multifunctional policy in France, taking into account this term of trade effect. To deduce the optimal subsidy level *S''*, we formalise J(y) as a function of *x*, as we did in section 2. We write $J(y) = M(x(y))$. Hence, $J'(y) = M'(x) \cdot \frac{dx}{dy}$.

M'(*x*) is the total marginal cost in Argentina and France beef markets. At free-trade world price level p_m, $M'(x^*) = 0$.



Graph 3. Extra-territorial effects of agricultural support.

Beef subsidy in France has an uncertain impact on national welfare (IKMJ - GHI) because it leads to changes in world prices (terms of trade effect). Effects on Argentina is always negative (ADFE). Because BCFE = IKLJ. And if we do not take into account the public good effects, the effect of beef support in France is always negative: -ABE-CDF-GHI-KMN.

To integrate the public good effect, we note that M'(*x*) equals -ABE -CDF -GHI –KMN. M'(z) is increasing in *x* for all $x > x^*$ because all of its components are decreasing in *y* for all $y > y^*$. Finally, because we assume $\frac{dx}{dy}$ >0 for all $y > y^*$, it follows that $M'(x) \cdot \frac{dx}{dy}$ is increasing. The value of the globally optimal subsidy *s''* is given by the equilibrium condition : M'(*x*) = *g(x)*

Following (3) and (5) we deduce the optimal agricultural subsidy *s''* taking into account welfare effects in both Argentina and France. s'' is such as :

$$J'(y) = M'(x) \cdot \frac{dx}{dy} = g(x) \cdot \frac{dx}{dy}$$

Finally, we prove that J'(y) is greater than L'(y):

- In the case of a closed economy, we have L'*(y)* = BC = *s'*
- In the two-country case, J'*(y)* = GI + NM + BE + CF = $(p_i - p_m) + (p_m - p_{m'}) + 2.(p_m - p_{m'}) = p_i + 2.p_m - 3.p_{m'}$

Because $p_i - p_m = s'$, it follows that J'*(y)* =s+2$(p_m - p_{m'})$, hence 0<*s''*<*s'*.

Result 3
In the two-country case, the globally optimal agricultural subsidy for the promotion of public good is strictly positive even if an alternative way to obtain the public good at a constant marginal cost exists.

CONCLUSION

We consider two different ways to model the linkage between a farm commodity output and a public good. In the first case, the public good is an output of a multi-output cost function and the optimal policy is a pricing of this output. Under the assumption of economies of scope, which generally corresponds to low level of production, we show that the separation of the two types of outputs is more costly than the joint production.

In the second case we consider the public good as an explicit externality of the commodity production. We show that when a non-agricultural supply of public good is made possible, a separation of these two types of goods is more costly for a low level of production, and becomes less costly when production increases. The optimal policy is then a combination of both policies. We show further that in the two-country case, the optimal agricultural subsidy once extra-territorial effects have been taken into account remains strictly positive, but is lower than in the case of a closed economy.

We draw three consequences on policy design :

- Because of economies of scope, the common recommendation of targeting policies in such a way that the policy has the least effect on agricultural production is not necessarily welfare improving, from a domestic point of view, in areas with conditions where the level of production is low and factors are unconstrained. Production subsidy combined with a non agricultural provision of the public good is pareto improving compared with the case where an environmental policy is set only.
- Protectionism or subsidies that could help enhance multifunctionality in a given country may generate a net cumulative welfare that exceeds the level created through free trade. However, a “multifunctional” policy (i.e. that would be motivated by public goods reasons) in large countries modifies the terms of trade and creates both winners and losers in comparison with free-trade. For both importing and exporting countries, the nationally optimal policy differs from the policy maximizing global welfare. This latter includes a certain level of agricultural support in the multifunctional importing country that would partly internalise the terms of trade effect of the agricultural policy. The rest of the public good should be produced through the non agricultural sector until global optimum is reached.

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