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Analysis

Agricultural public policy: Green or sustainable?

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ABSTRACT

The future of agriculture constitutes a major challenge to the achievement of sustainable development. There are new perspectives on greening (focusing on ecological objectives) and sustainability (combining both ecological and social goals). Academic papers mainly study the ecological efficiency of agricultural public policies, while real public policies, such as the European Common Agricultural Policy, examine both ecological and social considerations. The objective of this paper is to consider economic, social and ecological objectives within the design of agricultural public policies. Using a bio-economic model applied to France, we compare different optimal public strategies. We show that, when the biodiversity objectives are either very limited or very demanding, grassland subsidies are the best instruments from both green and sustainable points of view. However for medium objectives, reducing crops subsidies is the cheapest way to green the CAP, while subsidies on grasslands are the only strategy from a sustainability perspective. Our work highlights new trade-offs related to policy implementation, such as social acceptance or technical difficulties, and the spatial equity of performance among regions.

1. Introduction

Developing sustainable agriculture will be a major challenge in the coming decades, and particularly with regard to the impact of agriculture on the environment (Tilman et al., 2002). Changes in agricultural practices, including intensive cropping, landscape homogenization, loss of semi-natural elements, mechanization and intensive use of inputs, have had several consequences such as increased water pollution (Carpenter et al., 2012; Tong and Chen, 2002; Volk et al., 2009) and the loss of biodiversity (Chamberlain et al., 2000; Foley et al., 2005; Tilman et al., 2001; Tscharntke et al., 2005). In particular, consequences for biodiversity are widespread since many taxa are affected: see Flowerdew and Kirkwood (1997) for mammals, Sotherton and Self (2000) for plants and Donald et al. (2001) for birds. These negative effects are due mainly to degradation of habitat quality altering nesting success and survival (Benton et al., 2003). As a result, ecological considerations are increasingly being integrated into agricultural policy. For example, in Europe, such considerations have been introduced since the 90s through the European Common Agricultural Policy (CAP). Notably, agri-environmental schemes were developed to promote protection of biodiversity. However 15 years after their implementation, their effectiveness remains controversial (Kleijn et al., 2006; Vickery et al., 2004; Whittingham, 2007). The management of biodiversity in farmlands is still an open question, especially with ongoing debates about ways to improve the use of the dedicated budget into the CAP.

In addition to these environmental considerations, the socio-economic consequences of the CAP are not ubiquitously positive, even though the agricultural incentives originally were developed for economic reasons. By subsidizing production, the goal was to ensure minimum levels of income for farmers. However, this strategy has encouraged a process of intensification, generating a two-speed agriculture (Strijker, 2005). On the one hand, in the regions capable of intensification, the CAP process has stimulated enlargement of intensive farms and increased yields, generating high incomes and profits. On the other hand, in regions where intensification is impossible, incomes have remained low and the process of land abandonment has started (MacDonald et al., 2000; Mottet et al., 2006), which is deepening the gap between rich and poor farmers. More nuanced social considerations, concerning poverty for example, have now been integrated into the CAP.

Ecological and social criteria are currently being integrated with the historical economic objectives of the CAP. More precisely, they are part of a structure referred to as the "second pillar", the first pillar being the historical support for production and incomes (Lowe et al., 2002). Although the public policy instruments that are part of this second pillar seem to be socially acceptable (Prager and Freese, 2009), they have been strongly criticized for their ecological inefficiency (Kleijn et al., 2001; Stoate et al., 2009). The gap between the real objectives of the CAP and those studied in the literature opens interesting questions about the objectives of future CAP: do the objectives have to focus on ecological considerations or are they in line with sustainability perspectives by considering ecological and social criteria? In other words, is the objective to green the CAP or to make it more sustainable? While the second pillar of the CAP is now defined from sustainability point of view (Sutherland,

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2002), the question of greening CAP remains crucial in current debates (Scherr and McNeely, 2008). The originality of this paper lies in its contribution to these two viewpoints. We compare green public policies on the one hand and sustainability policies on the other.

There are various strategies to design public policies. More specifically agricultural public policies frequently are aimed at two different agricultural systems. The first concerns crops, which are characterized by high average incomes, and are associated with strong average negative impacts on biodiversity (Chamberlain et al., 2000; Donald et al., 2001; Stoate, 2001). The second concerns grasslands, which are associated with lower average incomes but have a more positive effect on biodiversity by preserving the natural habitats essential to many species (Laiolo, 2005). However, the impact of land-use and land-use changes on biodiversity are more complex since it has been shown that their ratio is a key element for biodiversity (Robinson et al., 2002). To impact these land-uses, price instruments (taxes or subsidies) are today considered by decision-makers, since they are applied to crops and grasslands respectively within the first and the second pillars of the current CAP.

In this paper, we compare green and sustainable public policies based on economic tools applied to crops or grasslands. Public policy scenarios are designed following an optimal under constraint approach in which the decision-maker maximizes a welfare criterion under social or ecological constraints. The optimal instruments are analyzed and the consequences on different criteria (welfare, social, biodiversity) due to the introduction of these new constraints are compared at different scales.

The paper is organized as follows. Section 2 presents the bio-economic model and the scenarios. Section 3 describes the case study. Sections 4 and 5 are devoted to the results and the discussion.

2. The Bio-economic Modeling

The bio-economic model in this paper extends the model developed in Mouysset et al. (in press), which links the economic decisions of representative farmers to environmental quality and biodiversity at local scale. In the present paper, a third component related to national scale public policy has been added. This multi-scale model is depicted in Fig. 1. A decision-maker chooses public policy scenarios, that impact on the choices of the farmers and thus, in an indirect way, affect habitat quality and biodiversity. Although the ecological equations remain similar,[1] the introduction of public policy levers modifies the equations of the economic model.

2.1. The Economic Model of the Farmer

As in Mouysset et al. (in press), each region r is assumed to be managed by a representative farmer who determines the areas $A_{r,k}(t)$ of each land-use k to maximize his expected utility depending on the mean and dispersion of incomes. However the income function now includes public policy incentives in addition to agricultural rents:

$$Inc_r(t) = \sum_k A_{r,k}(t).gm_{r,k}.(1+\tau_k) \tag{1}$$

where $A_{r,k}(t)$ denotes the areas dedicated to the land uses k in the region r, $gm_{r,k}$ represents the associated expected gross margin, and τ_k the economic incentives applied to the land-use k ($\tau > 0$ for subsidies, $\tau < 0$ for taxes).

Similarly to that in Mouysset et al. (in press), a quadratic form is used for the utility function to characterize the representative agent per small agricultural region:

$$U_r(t) = \mathbb{E}[Inc_r(t)] - a.\mathbb{V}ar[Inc_r(t)] \tag{2}$$

[1] See Appendix A and Mouysset et al. (in press) for the details of the ecological modeling.

based on the expected income $\mathbb{E}[Inc_r(t)]$, its risky part $\mathbb{V}ar[Inc_r(t)]$ (based on the covariances between gross margins of land-uses k and k' in region r), and the risk aversion level of farmers a (see details in Mouysset et al., in press).

The maximizing program of farmer's utility in an uncertain context is defined as follows:

$$\max_{A_{r,1};\dots;A_{r,K}} U_r(t). \tag{4}$$

Furthermore, when maximizing the utility, the standard agent must comply with three constraints at each point in time:

$$|A_{r,k}(t) - A_{r,k}(t-1)| \leq \varepsilon.A_{r,k}(t-1) \tag{5}$$

$$\sum_k A_{r,k}(t) = A_r \tag{6}$$

The first constraint (Eq. (5)) corresponds to a technical constraint where the coefficient ε stands for the rigidity in changes. The second one (Eq. (6)) is a stability constraint ensuring the total agricultural surface A_r per region constant.

2.2. The bio-Economic Indicators for the Stakeholder

The performance of the ecological-economic model can be analyzed using different indicators. These indicators are used for the design of public policies. The decisions of stakeholder are based on the classical welfare criterion. This welfare corresponds to the total wealth of society on a national scale. It includes the economic states of both private agents (farmers) and public agent (the budget available to subsidize farmers, provided from the general taxes levied society). In other words, welfare corresponds to the evolution in net income generated by the farms, excluding transfers (taxes and subsidies).

The private richness of farmers is analyzed through national income $Inc(t)$ (Eq. (7)) computed as the sum of the product of micro incomes $Inc_r(t)$ (as defined in Eq. (1)):

$$Inc(t) = \sum_r Inc_r(t) = \sum_r \sum_k A_{r,k}(t).gm_{r,k}.(1+\tau_k). \tag{7}$$

The public wealth corresponds to the non-spent public budget defined below, where Env represents the initial available envelope:

$$Budg(t) = Env - \sum_r \sum_k \tau_k.gm_{r,k}.A_{r,k}(t) \tag{8}$$

The total richness is computed as the sum of private and public wealth (Eq. (9)). Because of the public policies modifying rents or constraints on land-use, the $A_{r,k}(t)$ chosen by the farmers differs according to the scenario, leading to some variations in total wealth.

$$Rich(t) = Inc(t) + Budg(t) = \sum_r \sum_k gm_{r,k}.A_{r,k}(t) + Env. \tag{9}$$

Finally we define inter-temporal total richness among time $Rich$. This corresponds to the sum of total of richnesses discounted at the rate ρ from the first year of the projection t_1 to the final time horizon T:

$$Rich = \sum_{t=t_1}^{T} \rho^{t-t_1} \ . \ Rich(t) \tag{10}$$

Social and environmental criteria are considered constraints by the decision-maker. First in a social perspective, the objective is to defend the poorest farmers. Following a maximin perspective (Heal, 1998;