Re-considering Agri-Environmental Schemes premiums: the impact of fixed costs in sign-up decisions.

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Abstract— **Current EU legislation states that premiums for agri-environmental schemes must be calculated based on forgone profit and additional costs. This approach has been implemented for the last decades without much success in farmer uptake, a situation that might even worsen as the 20% additional payment as incentive for participation has been excluded in the new EU Rural Development Framework 2007-2013. This paper tries to explain why supply side estimated premiums might not suffice to assure farm profitability investigating the role that fixed costs have on adoption. A farm profit maximizing model is proposed where fixed and transaction costs are split from variations in marginal profit. This model is then developed to identify the potential barriers to adoption associated with the presence of fixed compliance costs. A sample of farmers eligible for an agri-environmental scheme entailing a land-use change is used to test whether the theoretical models are valid for explaining adoption decisions. Two different econometric specifications are used to identify the role of fixed costs, one assuming that uptake and surface decisions are governed by the same variables and another distinguishing both decisions. Estimation results show that there is an adoption barrier derived from the initial farm technical assets and know-how affecting the fixed compliance costs of introducing the new crop. Therefore not compensating for fixed costs can curtail agri-environmental policy success. In addition, there is an adoption barrier derived from transaction costs which are reduced in the presence of social networks.**

Keywords— **Agri-environmental schemes, fixed costs, adoption.**

I. INTRODUCTION

Agri-environmental schemes (AES) are the main policy instrument currently available in the European Union to foster improvements in the relationship between agriculture and the environment. Prior research has identified that premiums based on forgone profit might not be sufficient to assure farmer participation, as risk-related issues can require premiums to more than cover the mean loss in profit is associated with adoption [1]. This theoretical assumption is corroborated estimating the additional payment as the difference between contingent valuation estimates of willingness to accept with actual forgone profits. Additionally the sign-up decision is not solely affected by farm technical characteristics [2], and premiums show a limited effect in fostering adoption, specially for low requirement measures. This findings together with the low enrolment rates detected throughout the EU for AES[1], suggest that the 20% incentive was not sufficient to foster AES sign-up. This paper expands the understanding of how supply side estimated premiums affect AES participation, introducing the consideration of the potential effects of fixed costs associated with sign-up.

Several studies have considered factors influencing farmers' participation, which can be categorised in four main categories [4]. Programme (type of measure, compensation paid, application costs, etc.) and market (demand for food and environmental quality) characteristics constitute the so-called extrinsic factors while farm (size, crop portfolio, etc.) and individual farmer (age, education, etc.) characteristics are intrinsic factors. Fixed costs related to adoption would cover all costs that do not vary with the amount of area enrolled, and are mainly related with investments (both in assets and know-how) needed to implement AES. An additional source of fixed costs can be transaction costs (TC), which are increasing with asset specificity. Assets can be considered specific when they are sunk, i.e., not profitable in any another activity. Therefore, actions and warrants needed to secure the transaction entail transaction costs which are themselves sunk. There is empirical evidence that AES requiring higher specific assets involve higher transaction costs, and that some transaction costs do not depend on the enrolled area: they are fixed costs [5]. Logically, such fixed transaction costs should run in parallel to fixed costs of specific assets. For cases where schemes imply on a change in the crop pattern, one special case of FC is related to the effect of the specific technology used in the crop produced previously to the implementation of the AES. A higher investment or specialization of the farmer implies higher land profitability, inducing a higher loss when the crop is removed.

This paper tests whether fixed costs do indeed exist for AES implementation when these are asset specific and

[1] While Austria, Finland and Luxembourg have more than two thirds of the UAA involved in agri-environmental measures; in Belgium, Denmark, Greece, the Netherlands and Spain the coverage is just a mere 5% of their total Utilised Agricultural Area [3].

therefore provides evidence on whether the current approach to set premiums levels is adequate to foster adoption of this type of schemes.

II. CONCEPTUAL FRAMEWORK

The presented model considers that farmers when faced with the option whether to sign-up or not for an AES behave as profit maximizers. Adoption is geared by the increase in land profitability derived from a change in practices and/or land allocation. The profit structure is defined as to consider the effects of fixed costs associated either with current or alternative land management and transaction costs associated with AES implementation. For a simplified two activity model, where activity *c* is considered current practice and activity *a* the alternative proposed under a determined AES, this profit function can be presented as Equation 1. Farmers' face a surface restriction in which the total eligible area (S_T) is allocated between the two competing options, current production (S_c) and AES implementation (S).

$$Max\Pi = \overbrace{\Pi^c(p_c, S_c, Z^T) - FC_C(Z^T)}^{a} + \overbrace{\Pi^a(p_a, S, Z^T) - FC_a(Z^T)}^{b} +$$
$$\overbrace{\rho S_a - TC(Z^T, Z^{SCt})}^{c} \quad \text{st} \quad S_T = S_C + S \qquad (1)$$

Profit is split into three components, that associated with current production (a), that derived from implementation of AES (b) and that related with AES premium (ρ) and transaction costs (TC) (c). For each land use option, fixed costs are separately considered. Production associated profit depends on input-output prices (p_i), the area under cultivation (S_i) and technical factors (Z^T). Fixed costs (FC_i) are assumed to be totally explained by $Z^{T,}$ while fixed TC associated with AES implementation depends on Social Capital variables (Z^{SC}). Individual crop profit functions are assumed to be increasing and quasi concave with respect to the area allocated to the corresponding crop.

To gain understanding on the effect of FC on sign-up decision, two cases are considered. In the first case, land use *a* existed before AES implementation and in the second it did not. If land use *a* was already present in the farm, the land allocation equilibrium before AES implementation requires that fixed costs are covered for both crops and marginal returns are equal (Equation 2), where S* is the optimal area for use *a*.

$$\Pi_s^c(S_T - S^*) = \Pi_s^a(S^*) \qquad (2)$$

The introduction of an AES displaces this equilibrium to S^{*AES} as marginal profit for land use a is increased as long as TC are covered (Equation 3), while fixed costs associated with each crop remain unchanged in the new allocation of land.

$$\Pi_s^c(S^{*AES}) = \Pi_s^a(S^{*AES}) + \rho \qquad (3)$$
$$\text{s.t } \Pi^c(S_T - S^{*AES}) - \Pi^c(S_T - S^*) + \Pi^a(S^{*AES}) - \Pi^a(S^*) + \rho S^{*AES} \geq TC$$

If land use *a* was not present in the farm before AES implementation, fixed costs start playing a role. The restriction in equation 3 must be re-written to take this into account and is re-written as Equation 4.

$$\Pi^c(S_T - S^{*AES}) - \Pi^c(S_T) + \Pi^a(S^{*AES}) +$$
$$\rho S^{*AES} \geq TC + FC_a \qquad (4)$$

Fixed Costs related to current land use are not considered, as they do not change with the reduction of cereal area, although they might play a role through their effect on land profitability related to this use, specially if they are not recoverable (i.e. sunk costs).

III. CASE STUDY

In order to test this hypothesis, a sample of eligible farmers for the Alternative Crop AES[2] have been surveyed. Alternative Crop AES requires allocating rain-fed land to alfalfa, thus fitting our theoretical model and allowing to consider farmers who already have this land use and those facing a land use change. Overall this measure can be considered as a high-asset specificity one due to the change in the crop pattern involved. This change demands know-how and increases opportunity cost as alfalfa harvest is not assured due to weather variability. Fieldwork has been undertaken in Northern Spain with 156 dry-land farmers, 40% of which had enrolled in this particular AES. The final version of the questionnaire gathered data regarding three main topics: a) farm basic data with special interest in cattle management, b) attitudes, opinion, knowledge and enrolment in AES and c) basic farmer socio-economic data[3].

In order to evaluate the structural decision on AES adoption and to assess to what extent "fixed costs" is limiting adoption, two econometric models have been estimated. First, results from a double censored tobit model

[2] A detailed description of the measure requirements can be found in BOA [6].
[3] The questionnaire is available upon request to the authors.

on the area enrolled are compared with a probit model reflecting the decision to participate on the program. The double censored tobit model best suits a situation where FC are not relevant, that is Equation 1 minus the FC and TC components. If this model is solved without considering the surface restriction, the optimal surface allocation to use *a* (S^{**AES}) can be negative, compliant with the restriction or higher than the available eligible area. It would represent the dual value of the marginal profit of land if the farmer were obliged to contract. The actual enrolled area S has the following characteristics: it is a left censored variable, since it equals zero when the contract is not profitable; it equals S^{**AES} when the surface restriction in Equation 1 holds; and is also a right censored if S^{**AES} exceeds ST. The most suited econometric specification for this type of variable is a simple tobit with upper and lower censures and S^{**AES} as a latent variable. Under this modelling framework, determinants of fixed transaction costs, like the source of information about AES or the investment in skills, must not be significant. If this is so, the tobit results must be compatible with the probit estimation of the probability to enrol, because such a decision would also be governed by the same latent variable S^{**AES}.

The upper and lower bounded tobit model specification is defined in Equation 5 and parameters α estimated by the maximum likelihood.

$$\begin{array}{ll} s_i^{**AES} = Z_i\alpha + \varepsilon_i \quad E(\varepsilon_i) = 0 \quad E(\varepsilon_i^2) = \gamma^2 & \\ \text{if} \quad s_i^{**AES} \le 0, \quad \text{then } s_i = 0 & (5) \\ \text{if} \quad s_i^{**AES} \ge \text{eligible area, then } s_i = \text{eligible area} & \\ \text{if} \quad 0 < s_i^{**AES} < \text{eligible area, then } s_i = s_i^{**AES} = Z_i\alpha + \varepsilon_i & \end{array}$$

To test whether FC do play a role, estimates obtained from Equation 5 are compared with those obtained using a two-stage Heckman model. Unlike the tobit model, this approach explicitly splits the contracting behaviour into two decisions related to each other: participating or not in the AES and surface enrolled. This procedure allows identifying factors influencing adoption and area enrolled decisions separately. If results for the first step are different than those obtained in the tobit model, then some evidence regarding the role of FC can be obtained. Moreover, under the assumption that "fixed costs" are not related to the area enrolled in the AES, differences in estimates between sign-up and enrolled decisions would further support the presence of FC. If determinants significantly influence the adoption without influencing the area under contract, or influence both in opposite ways, this means that they are determinants of fixed costs and that fixed costs exists. If both adoption and enrolled area of contractors are governed by the same determinants and in the same way, it means that there are no significant fixed costs. In this case the adoption and the enrolled area both depend on the comparison between the offered premium and the difference in marginal returns of alternative land uses.

The first step of the Heckman method is a probit model analysing the probability of contracting based on the assumption of payment higher than the change in profit, taking into account both transaction and fixed costs as defined in Equation 1. The latent variable of the probit model, z, is defined in Equation 6, z is the difference in profit with and without contract, assuming farmers consider the optimal enrolled area if they would be obliged to contract. The results of the first step are used to calculate the inverse mills ratio (λ). The second step models the contracted area (S^{*AES}) using a OLS regression, including λ to take into account the outcomes of the first step. This parameter accounts for differences between participants and non-participants captured by the error term. The contracted area is the optimal area, given the contract is accepted.

$$z = \Pi^c(S_T - S^{*AES}) - \Pi^c(S_T - S^*) + \Pi^a(S^{*AES}) - \Pi^a(S^*) + \rho S^{*AES} - TC - FC_a \quad (6)$$

This double decision framework is modelled as follows:

$$\begin{array}{lll} z_i = Z_i\beta + u_i & E(u_i) = 0 & E(u_i^2) = \sigma^2 \\ s_i^{*AES} = Z_i\alpha + \varepsilon_i & E(\varepsilon_i) = 0 & E(\varepsilon_i^2) = \gamma^2 \\ \text{cov}(u,\varepsilon) = \theta.\gamma.\sigma & \forall i & \end{array} \quad (7)$$

Where Z is the vector reflecting variables which are assumed to affect the enrolment decision and/or surface enrolled. The function Φ is the cumulative function of the reduced and centred normal distribution and φ the corresponding density function. The first step is modelled as a simple probit model where:

$$\Pr[Y_i = 1] = \Pr[z_i > 0] = \Phi\left[Z_i \frac{\beta}{\sigma}\right] \quad (8)$$

This model allows estimating β/σ under the assumption of normality for u_i. For the second step the conditional expected value of the area enrolled, S_i^{*AES}, is calculated imposing that Z_i is strictly positive. Parameters α and $\delta = \theta\gamma$ can be estimated without bias by OLS for $s_i > 0$. The optimal area under contract is derived from Equation 3 unrestricted, therefore depending on farm technical factors affecting the marginal profit of both crops, and not affected by fixed costs.

$$E(s_I^{*AES} / z_i > 0) = E(Z_i\alpha + \varepsilon_i / z_i > 0) = Z_i\alpha + \delta \overbrace{\frac{\varphi\left(Z_i \frac{\beta}{\sigma}\right)}{\Phi\left[Z_i \frac{\beta}{\sigma}\right]}}^{\lambda} \quad (9)$$

In order to test the effect of fixed costs the following assumptions are put forward. Using the same explanatory variables to model the contracted area (S^{*AES}), if there were no fixed costs, the estimated coefficients in both steps will be similar, scaled by λ, that is the latent variable and enrolled area only depend on the comparison between the offered premium and the difference in marginal returns of alternative land uses. If not, the effect of technical variables limiting adoption, due to asset specificity cereal specialization, new compliance costs associated with the introduction of alfalfa and/or TC, would be detected.

For the objective of this research, fixed cost definition becomes a key issue. Fixed costs are related to fixed "compliance costs" associated with new land use specific investments and know-how, as well as to the pre-existing land use investments and fixed transaction cost related to information gathering before contracting, contract signing and bureaucratic costs for the contract follow-up.

IV. RESULTS

Tables 1 and 2 display the results from the double censored model estimation (Equation 5) and the results of the estimation of the two-step Heckman model (Equations 8 and 9 respectively). The comparison of the double censored tobit model and the first stage of the Heckman method supports the existence of fixed costs, as technical variables which are significant for the sign-up decision do not influence the enrolled area for the full sample (IRR_CER, OVINE) and vice versa (ELI_AREA). Additional support for this hypothesis is obtained comparing both steps in the Heckman model, as significant technical variables of the first step are no longer significant for the second and there is a sign reversal for the presence of livestock which positively affects sign-up and negatively enrolled area.

Some information regarding the nature of the fixed costs associated with this AES can be obtained from a detailed analysis of individual variables. Social capital variables, which are significant for the adoption and are not for the enrolled area, would reflect that fixed costs are not only technical in nature but include transaction costs. Technical variables describing specialisation in cereal crops impede adoption, while the presence of alfalfa before the scheme or the presence of irrigated alfalfa favours adoption. This points at crop management know-how as a potential source of fixed costs although cereal specialization could be signalling higher marginal profits for this crop and the presence of corner solutions due to a lack of total surface (i.e. $S^{**AES} > S_T$).

Table 1 Double censored tobit model for area enrolled and % of eligible area enrolled as dependent variables

		Area enrolled		Share area enrolled/eligible area	
	Variable	***Coeff.***	***p-value***	***Coeff.***	***p-value***
	Constant	-0.721	0.9321	0.293	0.0516
Z^T	Eligible area (number of ha) (ELI_AREA)	0.162	0.0000	-1.820	0.9793
	Non-irrigated cereal specialization farmer (1 if yes) (SPE_NIRR_CER)	-27.151	0.0015	-0.479	0.0022
	Crop distribution includes irrigated cereal (1 if yes) (IRR_CER)	-8.237	0.2621	-0.308	0.0187
	Farm owns harvester (1 if yes) (HARV)	-52.491	0.0018	-0.491	0.0641
	Farm already had pulse crops before AES (1 if yes) (NIRRI_ALF)	14.447	0.0274	0.243	0.0415
	Crop distribution includes irrigated alfalfa (1 if yes) (IRRI_ALF)	15.343	0.0262	0.326	0.0085
	Presence of livestock in the farm-hold (1 if yes) (OVINE)	-3.706	0.5822	0.035	0.7735
Z^{sc}	Farmer is a member of a cooperative (1 if yes) (COOP)	-11.308	0.1202	-0.310	0.0168
	Farmer attends agricultural formation courses (1 if yes) (FORM)	5.377	0.4120	0.079	0.5063
	Farmer obtains information from financial entities (1 if yes) (FIN_ENT)	24.709	0.0188	0.230	0.2279
	Farmer uses more than one source for advice (1 if yes) (ADD_INF)	8.826	0.2686	0.178	0.2152
γ		26.583	0.0000	0.487	0.0000
Model Fit Statistics		N = 104 -2log likelihood = 542.578		N = 104 -2log likelihood = 142.764	

Table 2 Two-Step adoption model for the Alternative Crop AES

		Sign-up decision (z)		Area enrolled (s)	
	Variable	***Coefficient***	***p-value***	***Coefficient***	***p-value***
	Constant	-0.322	0.4231	41.954	0.0485
Z^T	Eligible area (number of ha) (ELI_AREA)	0.002	0.3305	0.144	0.0004
	Non-irrigated cereal specialization farmer (1 if yes) (SPE_NIRR_CER)	-0.894	0.0494	-5.510	0.5760
	Crop distribution includes irrigated cereal (1 if yes) (IRR_CER)	-0.957	0.0086	13.034	0.1958
	Farm owns harvester (1 if yes) (HARV)	-2.048	0.0149	-17.236	0.4352
	Farm already had pulse crops before AES (1 if yes) (NIRRI_ALF)	1.091	0.0016	-9.108	0.3804
	Crop distribution includes irrigated alfalfa (1 if yes) (IRRI_ALF)	0.597	0.0982	8.580	0.2607
	Presence of livestock in the farm-hold (1 if yes) (OVINE)	0.765	0.0269	-24.212	0.0128
Z^{SC}	Farmer is a member of a cooperative (1 if yes) (COOP)	-0.702	0.0647	0.052	0.9948
	Farmer attends agricultural formation courses (1 if yes) (FORM)	0.869	0.0176	-10.724	0.2228
	Farmer obtains information from financial entities (1 if yes) (FIN_ENT)	1.822	0.0136	0.222	0.9876
	Farmer uses more than one source for advice (1 if yes) (ADD_INF)	0.662	0.1425	5.740	0.5048
λ				-26.607	0.2198
Model Fit Statistics		N = 104 -2log likelihood model = 88.515 χ^2= 51.79 p-value= 0.0000 Mc Fadden R2 = 0.3691 % of correct predictions = 78.8		N = 62 R^2 = 49.6% χ^2= 57.01 p-value= 0.0000	

V. SUMMARY AND POLICY IMPLICATIONS

The results presented support that the adoption decision for the AES considered is influenced by the existence of fixed costs. Fixed costs are explained both by technical and social capital variables, and thus, are made up of both compliance and transaction costs. Technical FC for land use change are related to pre-existing assets in the farm. Specialized cereal growers with higher marginal profitability of land due to capital investments (harvester[4] or irrigation) are less willing to apply for the AES, as changes in the crop pattern involve not only lower marginal profits but also,loss of partly sunk costs.

Reported results are in line with those which identify the constraints involved by specific investments regarding the AES compliance costs [5]. In our case, more technically demanding measures such as those which imply a change in the crop pattern seem to highlight the role of fixed compliance costs making them less profitable and thus, less probable of being adopted, than measures where only marginal costs are at stake. If new AES promoted under the EU rural development programme for 2007-2013 want to follow a “deep and narrow” approach (i.e very specific measures with demanding crop and management changes) current legislative framework can be a barrier for success. Compensating for transaction costs might not suffice to assure enrolment, as fixed compliance costs can be independent of TC and curtail sign-up trough a (negative) effect on marginal profitability. Moreover, other strategies to increase adoption, such as the promotion of social networks to assure more efficient information dissemination and generating a reduction in transaction costs, albeit necessary[5], would not solve this problem if FC are relevant.

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