The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Efficient Procurement of Ecosystem Services – Adverse versus Beneficial Selection

Noel Russell[1] and Johannes Sauer[2]

[1]*Corresponding Author*: Economics, School of Social Sciences, The University of Manchester, Manchester M13 9PL, UK, noel.russell@manchester.ac.uk

[2]The University of Manchester, UK, and Christian Albrecths University of Kiel, Germany, jsauer@ae.uni-kiel.de

Contributed Paper prepared for presentation at the 86th Annual Conference of the Agricultural Economics Society, University of Warwick, United Kingdom

16 - 18 April 2012

Copyright 2012 by Noel Russell and Johannes Sauer. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

The role of adverse selection in schemes for the procurement of ecosystem services has been investigated by many who suggest that efficiency of these schemes is impaired by problems arising from adverse selection. However recent research on the UK Environmental Stewardship Scheme suggests that these types of procurement system may not be characterised by adverse selection but by what might be more appropriately labelled as "beneficial selection". These results are based on the analysis of a simple theoretical model and the empirical implications are confirmed using econometric analysis. However it is also suggested that, even with beneficial selection, there will still remain systemic inefficiency arising from a continuing need for the payment of informational rents to the farmers participating in the scheme.

This paper presents the analysis of a model that focuses on the Principal- Agent characteristics of this problem and sets out to investigate the tradeoffs that arise in designing ecosystem procurement mechanisms where payment of informational rents to participants can be used to increase overall efficiency. The impact of beneficial selection is carefully explored here, and we suggest implications for policy makers and empirical propositions to be tested using a suitable data set.

Keywords: Asymmetric Information, Beneficial Selection, Adverse Selection, Payment for Ecosystem Services

JEL codes: D82 Asymmetric and Private Information; Q57 Ecosystem Services;

Efficient Procurement of Ecosystem Services – Adverse versus Beneficial Selection

(RESULTS OF PRELIMINARY ANALYSIS: NOT FOR QUOTATION WITHOUT AUTHORS' PERMISSION)

The role of adverse selection in government schemes for the procurement of ecosystem services has been investigated by a wide range of authors, including Connor et al. (2008), Ferraro (2008) and Quillerou and Fraser (2010). The general consensus is that adverse selection impairs both the efficiency of these schemes and the value for money that they deliver to taxpayers and funding agencies. However, recent research on the UK Environmental Stewardship Scheme (Russell and Sauer, 2011) suggests that these types of procurement system may not be characterised by adverse selection but by what might labelled as "beneficial selection"[1]. Russell and Sauer base their results on the analysis of a simple theoretical model and confirm the empirical implications of beneficial selection using a unique dataset of the characteristics of agreement holders in the UK Higher level Stewardship Scheme. However they suggest that even with beneficial selection there will still remain potential inefficiency arising from a continuing need for payment of information rents to the participating farmers in the scheme.

This current paper extends this analysis using a more complete model that focuses specifically on the Principal- Agent characteristics of this problem and sets out to investigate the design tradeoffs that arise in ecosystem procurement mechanisms where payment of information rents might be used to increase overall efficiency. The impact of beneficial selection is carefully explored here, and we suggest implications for policy makers as well as empirical implications that might be tested using a suitable data set.

[1]Hemenway (1990) and de Meza and Webb (2001) discuss the closely related notions of "propitious selection" and "advantageous selection" respectively, in the context of markets for insurance. Fang et al. (2008) provide a more recent analysis of advantageous selection that focuses on markets for health insurance. In addition Quillerou et al. (2011) note the likely existence of "auspicious selection" in a UK Environmental Stewardship scheme, a concept they attribute to an anonymous referee.

Information Rents and Market Efficiency

In analysing the tradeoff between payment of information rents and market efficiency we focus on farmer participation in the Environmental Stewardship Scheme (ESS). We consider a scenario where a government agency offers contracts to farmers in order to ensure the supply of certain types of ecosystem services. In tendering for these contracts a farmer voluntarily agrees to manage a particular ecosystem according to specified rules in return for a conditional payment. The payments are intended to cover the farmer's costs of following these rules.

The analysis focuses on the asymmetric distribution of information between the agency and the farmer about these costs; each farmer knows their specific costs but the agency knows only the range of costs across farmers and their probability distribution. Thus we focus on the 'hidden information' that influences the behaviour of both parties prior to concluding the contract. We pay particular attention to the idea that farmers have better information than the agency about their costs of meeting the contract provisions and can secure higher payments by exaggerating their costs, using their private information as a source of market power to extract informational rents in the form of payments that exceed the minimum necessary to ensure their participation in the scheme.

The Basic Model: We assume that all farmers are capable of contributing to the supply of a single homogenous ecosystem service. The agency offers a contract that specifies which activities are to be undertaken by the farmer to facilitate supply of this service and a corresponding payment.

The costs of taking on the contract and participating in the scheme will depend on the activities required and the implied changes for existing farming operations; in our model these requirements are summarised in a single variable h, referred to as farmer 'effort'. In the context of the ESS 'effort' will include hectares entered into the scheme, changes to agricultural activities (e.g. changes in fertilizer application rates, cropping patterns etc.) and other conservation activities needed to provide the specified ecosystem service. The costs of participation will also depend on the characteristics of the farmer and the farming operation and these are summarised by a single variable γ, referred to as the farmer 'type'. Farmer 'type' reflects conservation opportunity costs on the land owned and will likely be related to agricultural productivity, management characteristics, etc.

The participation costs function can be defined as follows. $C = C(h, \gamma);\ C_h, C_\gamma > 0;\ C_{hh}, C_{\gamma\gamma} > 0;\ C_{h\gamma} > 0;\ C(0, \gamma) = 0$. Here we assume that marginal costs of participating in the scheme are positive and convex in both effort (h) and farmer type (γ). Assuming $C_{h\gamma} > 0$ reflects the 'Spence-Mirrlees' condition (see for example Laffont and Martimort, 2002) and requires that marginal costs of effort increase with farmer type[2]. The final assumption $C(0, \gamma) = 0$ asserts that zero costs are incurred when farmers exert zero effort[3].

Participating farmers are assumed to generate ecosystem benefits that depend on both farmer effort and farmer type giving the following benefits function:

$$B = B(h, \gamma);\ B_h, B_\gamma > 0;\ B_{hh}, B_{\gamma\gamma} < 0;\ B_{h\gamma} > 0$$

Marginal benefits are assumed positive and concave in effort and in farmer type; this latter asserts that for a given level of effort, the benefits delivered by higher productivity farmers are greater than those generated by lower productivity farmers, presumably reflecting the higher productivity of these farmers in generating both agricultural and ecological services. Assuming $B_{h\gamma} > 0$ asserts that the additional benefits of applying additional effort are also higher for higher productivity farmers[4]. These parallel the assumptions used in conventional models of contracting under asymmetric information.

In the simplified analysis in this paper we assume that farmers can be one of only two types; for farmers with high agricultural productivity and high opportunity costs of participating in the scheme γ = H, while for farmers with low opportunity costs γ = L , i.e. $\gamma \in \{H, L\}$. Thus the agency,

[2] This is a 'constant-sign' condition that also ensures the 'single-crossing' property of the farmer rent contour maps in figures 1, 2 and 3.
[3] This ensures that the break-even (zero) rent contours go through origin in figures 1, 2 and 3.
[4] This also represents the Spence-Mirrlees constant-sign single-crossing condition for the agency surplus contour maps in figures 1, 2 and 3.

acting on society's behalf, can offer farmers a menu of contracts, one for each type of farmer that specifies payment, $t(.)$ and effort,$h(.)$, i.e. $K^H = (t^H, h^H)$, $K^L = (t^L, h^L)$. Farmers will only consider accepting contracts that cover their opportunity costs i.e. where information rent, $R^H = t^H - C^H \geq 0$ and $R^L = t^L - C^L \geq 0$.

The Full information Scenario: Following the conventional approach to analysis of this type of problem, our benchmark solution assumes that the agency has full information about the specific type of each farmer and how type influences farmer costs and conservation benefits. In this scenario the optimal 'First Best' outcome involves offering each type of farmer individually a contract that pays the cost of providing the level of effort that equates the marginal cost and marginal benefit; i.e. choose $h^{*L} and\ h^{*H}$ such that $B_h^L = C_h^L\ and\ B_h^H = C_h^H$ respectively, and provide transfer payments that deliver zero information rent to each type of farmer i.e. such that $R^L = t^L - C(h^{*L}, L) = 0$ and $R^H = t^H - C(h^{*H}, H) = 0$. A graphical representation of these contracts (labelled $K^{*L}\ and\ K^{*H}$ respectively), is presented in Figure 1, where paying zero information rents to each type of farmer means that each contract lies on the zero-rent contour (R^L_0 and R^H_0 respectively) for each type of farmer.

Introducing asymmetric information: We contrast the First Best solution with the optimal solution obtainable when farmer's type is private information. This means that, while the agency can offer the first best optimal contracts as a menu of options it cannot now insist that each type take on the contracts intended for them. This means that while type H will accept $K^{*H} = (t^{*H}, h^{*H})$, type L will prefer to also take on K^{*H} since this contract provides greater rent than $K^{*L} = (t^{*L}, h^{*L})$. In figure 1 contract K^{*H} paying positive rent to L is denoted by the fact that it lies on the R^L_1 rent contour, the dashed line parallel to R^L_0. Thus the agency ends up being compelled to pay an information rent to L while at the same time it is accepting a level of output that is less than the first best efficient level. In these circumstances self-selection by the agent reduces efficiency and increases payments of information rents. However, we can show that the agency can improve on this situation by offering a more carefully calibrated menu of contracts that reduces the effort required of the high cost farmer (thus reducing efficiency) while paying a much lower (but still positive) rent to the low cost farmer. In other words the agency trades off some loss of efficiency against reducing rent payments.

The key property of this new menu of contracts is to ensure that $K^L = (t^L, h^L)$, the contract designed for L, is attractive only for L, while the contract designed for H, $K^H = (t^H, h^H)$ is attractive only for H. There are two parts to this; ensuring that the contracts are actually acceptable to their intended farmers (a *Participation* property), and ensuring that the contracts are not acceptable to the 'other' farmers (an *Incentive Compatibility* property). Formally, these can be imposed as constraints on the contract design problem as follows;

Participation Constraints: $t^L - C(h^L, L) \geq 0$ and $t^H - C(h^H, H) \geq 0$

Incentive Compatibility Constraints: $t^L - C(h^L, L) \geq t^H - C(h^H, L)$

$t^H - C(h^H, H) \geq t^L - C(h^L, H)$

These act as constraints on the Agency's menu of contracts that will generate an optimal outcome. In solving for this menu of contracts, rather than maximising some form of social welfare function, we follow much of the literature on asymmetric information (for example Laffont and Martimort, 2002; Canton et al, 2009; Bolton and Dewatripont, 2008) and assume that the Agency maximises the surplus arising from the excess of benefits generated over transfer payments; in the context of the UK ESS (and PES schemes in general) this is equivalent to maximising an additive measure of 'value-for-money'. This objective function (where θ is the proportion of farmers of type L) may be specified as follows:

$$\max_{(\mathrm{tH,hH})(\mathrm{tL,hL})} \theta\,[B(h^L, L) - t^L] + (1-\theta)[B(h^H, H) - t^H]$$

Using the definitions of information rents above, $R^L = t^L - C(h^L, L)$ and $R^H = t^H - C(h^H, H)$, we can rewrite this objective function as follows by substituting for t^L and t^H, giving:

$$\theta[B(h^L, L) - C(h^L, L)] + (1-\theta)[B(h^H, H) - C(h^H, H)] - [\theta R^L + (1-\theta)R^H]$$

This restatement of the problem implies that the Agency wishes to maximise the expected net conservation value less the expected payments of information rent and highlights the potential trade-off between a first-best efficient outcome that maximises the net environmental value generated by the contracts, and the possibility of accepting lower efficiency (i.e. ecological output that differs from the 'first-best' levels) in return for reductions in payments of information rent.

Defining the cost difference, $\Delta^H = C(h^H, H) - C(h^H, L)$[5], the Incentive and Participation constraints can also be rewritten in terms of rental payments and the cost of conservation effort as follows:

Participation Constraints: $R^L \geq 0$ and $R^H \geq 0$

Incentive Compatibility Constraints: $R^L \geq R^H + \Delta^H$ and $R^H \geq R^L - \Delta^L$

A conventional shortcut in solving this optimisation problem is to exploit the special structure of the constraints to eliminate from consideration the participation constraint of L (the low cost farmer) and the incentive constraint for H (the high cost farmer) since these will always be satisfied and non-binding with rational participating farmers. Both remaining constraints will be binding at optimum, giving $R^H = 0$ and $R^L = \Delta^H$, and we can substitute both into the objective function giving an unconstrained maximising problem:

$$MAX\ \ \theta[B(h^L, L) - C(h^L, L)] + (1-\theta)[B(h^H, H) - C(h^H, H)] - \theta\Delta^H$$

This differs from the maximand in the first best scenario only by the subtraction of expected rent payments to L, the low cost producer. It can be shown that since this rent depends only on the effort of H (not L) the second best outcome for L, $\hat{h}^L$ will be identical to the first best outcome, h^{*L}, i.e. the first order condition with respect to h^L is $B_h^L - C_h^L = 0$ as in the first best scenario. However, the first order condition with respect to h_H now becomes $\left[B_h^H - C_h^H\right] = \frac{\theta}{(1-\theta)}\Delta_h^H$, so that, given declining marginal benefits of effort and the assumptions noted in footnote 9, $\hat{h}^H < h^{*H}$. Thus the

[5] These are the additional profits the low cost producer could achieve if they insisted on taking on the high cost contract. They represent the rental payments to this producer in order to induce them to accept the 'low cost' contract.

efficiency of effort by H is traded off against the payment of information rent to L; by reducing the effort required by H the Agency can reduce the rent it needs to pay to L in order to induce participation. This situation is illustrated in Figure 2.

In both figure 1 and figure 2 the contracts are presented as (transfer, effort) combinations. The first best contracts under full information (Figure 1) are $\mathrm{K}^{*\mathrm{L}} = (\mathrm{t}^{*\mathrm{L}},\ \mathrm{h}^{*\mathrm{L}})$ and $\mathrm{K}^{*\mathrm{H}} = (\mathrm{t}^{*\mathrm{H}},\ \mathrm{h}^{*\mathrm{H}})$. The second best contracts under asymmetric information (Figure 2) are $\widehat{\mathrm{K}}^{\mathrm{H}} = (\hat{\mathrm{t}}^{\mathrm{H}}, \widehat{\mathrm{h}}^{\mathrm{H}}) and\ \widehat{\mathrm{K}}^{\mathrm{L}} = (\hat{\mathrm{t}}^{\mathrm{L}}, \widehat{\mathrm{h}}^{\mathrm{L}}) = \mathrm{K}^{*\mathrm{L}}$. We can show that $\widehat{\mathrm{h}}^{\mathrm{L}} = \mathrm{h}^{*\mathrm{L}}$ and that $\widehat{\mathrm{h}}^{\mathrm{H}} < \mathrm{h}^{*\mathrm{H}}$ i.e. while it remains optimal for the low cost farmer to enrol the same area as under the first best scenario the optimal contract for the high cost farmer now requires that a lower area is enrolled. The diagram also illustrates that the transfer to H is reduced and still involves zero rent. By contrast, L is now receiving a positive rent.

The key results of this analysis can be summarised as follows. The optimal menu of contracts under the second best scenario with asymmetric information requires; a) effort from the low cost farmer at the same level as for the first best full information scenario; $\hat{h}^{L} = h^{*L}$ and $B_h^L - C_h^L = 0$; b) reduced effort form the high cost farmer; $\hat{h}^{H} < h^{*H}$ and $[B_h^H - C_h^H] = \frac{\theta}{(1-\theta)}\Delta_h^H$. In this scenario, information rent is paid only to the low cost farmer and this is lower than the rent that might have been paid using the 'first best' contracts as the second best contract menu; the rent payable is given by $\hat{R}^{L} = \hat{\Delta}^{H}$. The relevant transfer payments are given by $\hat{t}^{L} = C(h^{*L}, L) + \hat{\Delta}^{H}$ and $\hat{t}^{H} = C(\hat{h}^{H}, H)$.

Beneficial versus Adverse Selection

A key issue addressed in many previous studies of systems for ecosystem services procurement is that voluntary self-selection by the farmer participants adversely affects scheme efficiency and cost-effectiveness, because those most likely to join the scheme contribute least to the scheme objectives. This is illustrated in the basic model by the positive relationship between scheme benefits and farmer type asserting that ecological benefits are greatest on more agriculturally productive farms with highest opportunity costs. In these circumstances incentives to participate will be greatest among those low opportunity cost farmers who deliver least benefits. This is regarded as a particular problem where payment levels are related to average participation costs for a given group of participants since the probability of participating for profit maximising producers is negatively correlated with the opportunity costs of participation and thus with agricultural and ecological productivity. The resulting adverse selection has been highlighted in the Quillerou and Fraser study of the UK Higher Level Stewardship scheme and they go on to show that the impact of this is reduced to some extent by certain features of scheme implementation.

However, it has also been suggested that farmers with lower productivity land generate a higher level of ecological services. This is because the land is farmed less intensively and there is less damage to the ecological infrastructure. A number of studies confirm this in a European context, including Kleijn et al. (2009), Tscharantke et al. (2005), Reidsma et al. (2006) and Stoate et al. (2001). The Kleijn et al. paper also points out that conservation benefits are disproportionately less costly to achieve on low-intensity farms. Taken together these relationships imply that when participation is highest among farmers with lower participation costs it is *pari passu* highest among those farmers that generate higher levels of ecological services. This supports the idea that these schemes are characterised, not by 'adverse selection' that impairs scheme efficiency, but by an opposite phenomenon that might be described as 'beneficial selection'[i]. However, while this will reduce the costs of dealing with asymmetric information, it will not totally eliminate these costs, as noted below.

Implications of Beneficial Selection

Beneficial selection has been included in this model by assuming that conservation benefits are negatively related to the productivity characteristics of participating framers. This is represented in the analysis by letting conservation benefits depend on farmer type such that $B = B(h, \gamma);\ B_h > 0, B_\gamma < 0;\ B_{hh}, B_{\gamma\gamma} < 0;\ B_{h\gamma} < 0.$

The implications of this change are most clearly seen in the trade-off between efficiency and information rents that is at the core of the process leading to the optimal second best solution as discussed above and illustrated in Figure 3. The ability of the agency to adjust the contract for type H participant, thereby reducing the information rent payable to type L, depends on the balance between the loss in conservation benefits as h^H is reduced below its first best optimum and the gain from reduced rental payments. With beneficial selection described by the relationships and assumptions in the previous paragraph, the Agency will have more flexibility both in reducing rental payments and in reducing the loss in conservation benefits that this entails.

We are undertaking a two-stage empirical analysis using a dataset that combines information from scheme agreements and from the UK Farm Business Survey to describe the participation and farming characteristics of approximately 1000 agreement holders in the UK Environmental Stewardship Scheme. Stage one focuses on establishing that the core relationships in the model, between opportunity costs, ecological benefits and scheme participation, are supported by the data. Stage two then sets out to explore the extent to which self-selection by farmers can be seen as having adverse or beneficial effects on scheme efficiency. This is the subject of ongoing research.

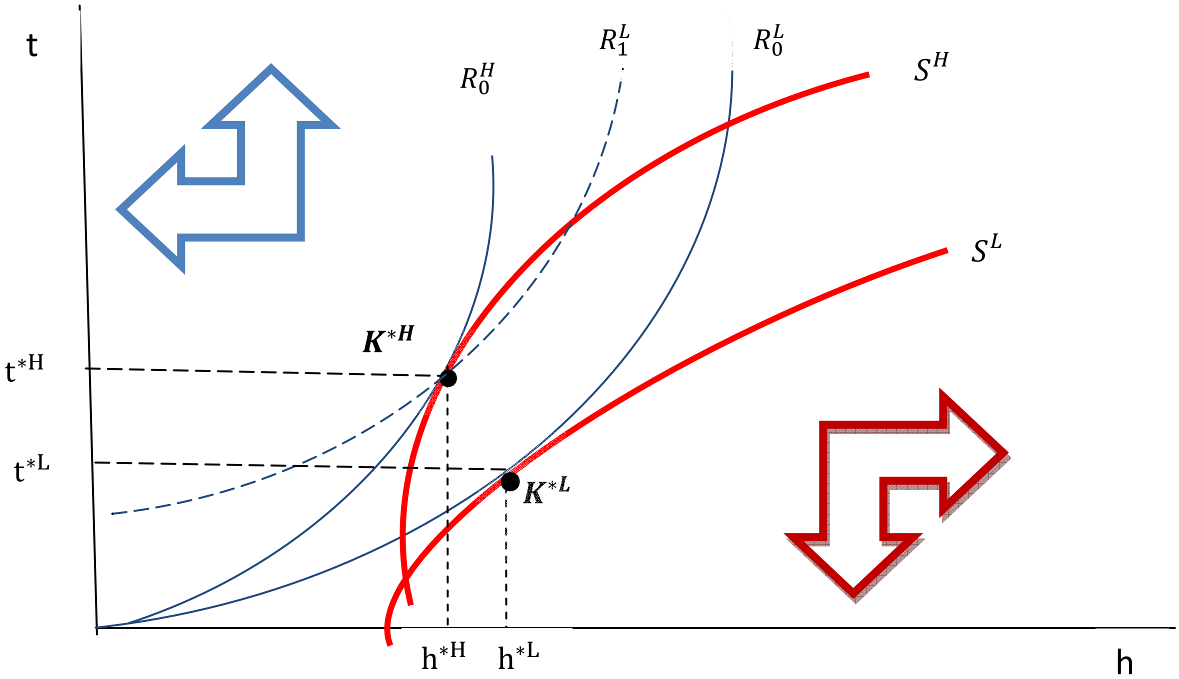

Figure 1. Menu of Contracts in the First Best full information scenario $K^{*L} = (t^{*L}, h^{*L})$ and $K^{*H} = (t^{*H}, h^{*H})$

Note: R_0^H and R_0^L represent the zero rent contours (participation constraints) for each type of farmer. S^H and S^L represent the Agency surplus contours from the agency's objective function. See Appendix A for a discussion of their relative slopes and curvatures.

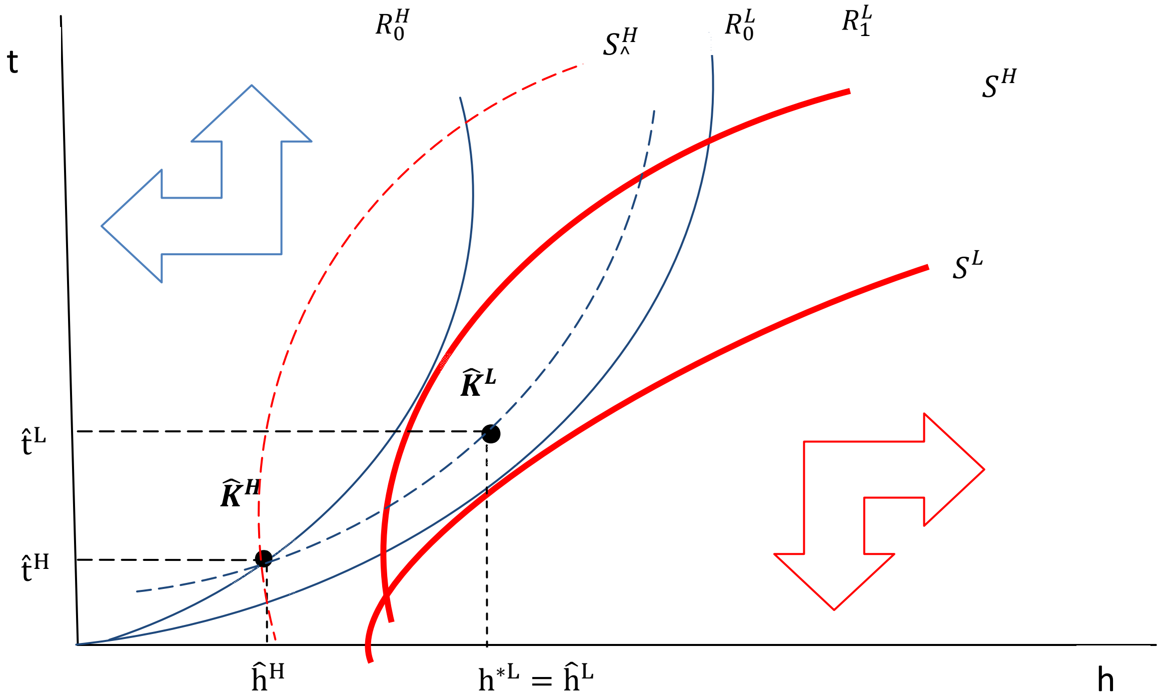

Figure 2. Menu of Contracts in the Second Best asymmetric information scenario with Adverse Selection, $\widehat{\mathbf{K}}^{\mathbf{H}} = (\hat{\mathbf{t}}^{\mathbf{H}}, \hat{\mathbf{h}}^{\mathbf{H}})$ ***and*** $\widehat{\mathbf{K}}^{\mathbf{L}} = (\hat{\mathbf{t}}^{\mathbf{L}}, \hat{\mathbf{h}}^{\mathbf{L}}) = \mathbf{K}^{*\mathbf{L}}$

NOTE: In the absence of full information the contract K^{*H}*, if offered, will be chosen by type L as well as by type H since it provides positive rents to type L. Making the menu of contracts incentive compatible means changing both contracts as indicated in the Second Best menu so that contract* $\widehat{K}^L$ *is at least as good as contract* $\widehat{K}^H$ *for type L (and will be chosen by L under the 'weak altruism' assumption). As in Figure 1* R_0^H *and* R_0^L *represent the zero rent contours (participation constraints) for each type of farmer.* S^H *and* S^L *represent the Agency surplus contours from the agency's objective function. See Appendix A for a discussion of their relative slopes and curvatures.*

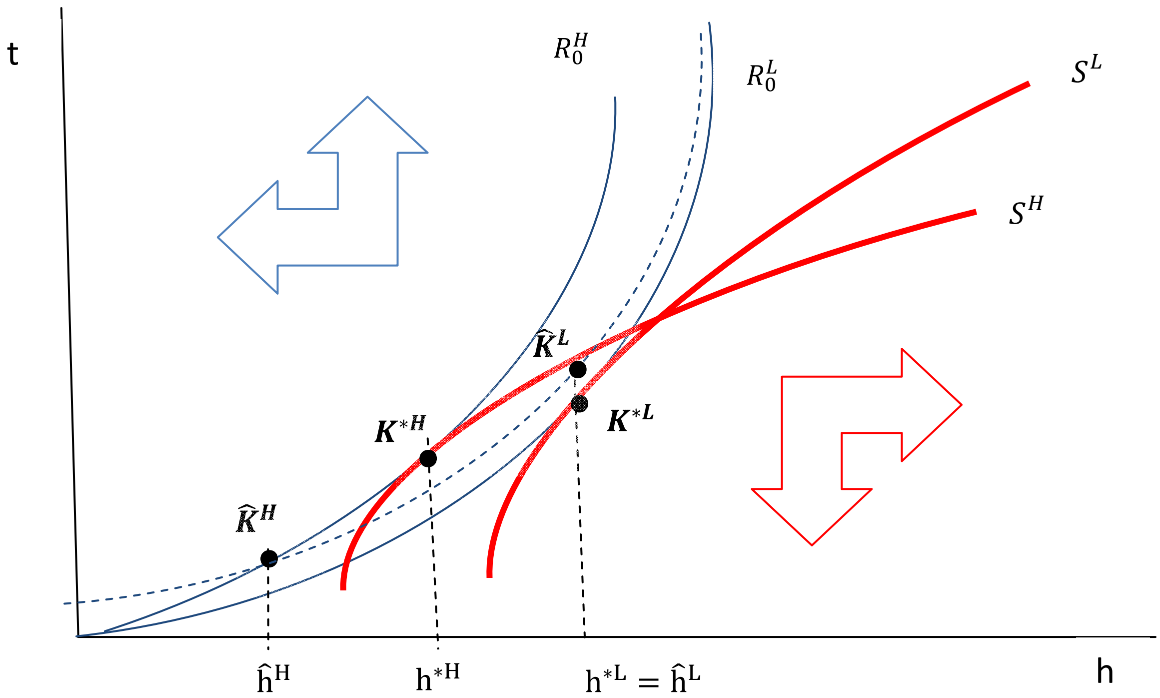

Figure 3. Menu of Contracts in the Second Best Asymmetric Information Scenario with Beneficial Selection $\widehat{K}^H = (\hat{t}^H, \hat{h}^H)$ *and* $\widehat{K}^L = (\hat{t}^L, \hat{h}^L) = K^{*L}$

NOTE: With Beneficial Selection the agency surplus contour for type H is now flatter than the corresponding contour for Type L (See Appendix A). As in the case of Adverse Selection the optimal second best contract points to a trade off between rental payments to Type L and systematic distortion of effort level for Type H away from the first best optimum level. However a comparison of Figure 2 with Figure 3 suggests that both rental payments to Type L and effort distortion for Type H are reduced compared to what happens with Adverse Selection.

Appendix A: Relative Slopes and Curvature of Farmer Rent and Agency Surplus Contours (See figures 1, 2 and 3)

Farmer Rent Contours:

These represent the 'contour map' in (t, h) space of the farmer's Rent function given by $R^{\gamma} = t(\gamma) - C(h_{\gamma}, \gamma) = 0$. For any given type, γ and transfer t, increasing effort, h, will lead to a reduction in rent accruing to the farmer since $C_h > 0$. Thus along a constant rent contour t must increase to compensate so the contour must be positively sloped. The convexity of the opportunity cost function, C , ensures that the contours are convex.

With $C_{\gamma}, C_{h\gamma} > 0$ the marginal cost of effort is increasing with type. Thus as h increases, rent for a farmer with higher type is declining faster, requiring a faster increase in t to compensate. Constant rent contours must therefore be steeper in (t, h) space for higher types.

Finally, given $C(0, \gamma) = 0$ (zero effort incurs zero costs for both types of farmer) the break-even zero rent contours must go through origin.

Agency Surplus Contours:

These represent the 'contour map' in (t, h) space of the Agency's Surplus function given by $B(h_{\gamma}, \gamma) - t(\gamma)$. For any given type, γ, increasing effort, h, will lead to an increase in the surplus accruing to the agency since $B_h > 0$. Thus along a constant surplus contour t must increase to compensate so the contour must be positively sloped. The concavity of the ecological benefits function, B, ensures that the contours are concave.

With $B_{\gamma}, B_{h\gamma} > 0$ the marginal ecological benefit of effort is increasing with type. Thus when dealing with a farmer of higher type a given increase in effort will require a larger increase in t to compensate by offsetting the additional benefits. Constant surplus contours must therefore be steeper in (t, h) space for higher types. Exactly the opposite reasoning applies when $B_{\gamma}, B_{h\gamma} < 0$ and this scenario is illustrated in Figure 3.

References

Bolton, P. and Dewatripont, M. (2005), Contract Theory, Massachusetts Institute of Technology Press.

Canton, J., S.De Cara and P.A.Jayet (2009). Agri-environmental schemes: Adverse selection, information structure and delegation, Ecol Econ 68(7):2114-2121.

Claassen, R., A.Cattaneo and R.Johansson (2008), Cost-effective design of agri-environmental payment programmes: US experience in theory and practice, Ecol Econ 65(4):737-752

Connor, J.D., J.R.Ward and B.Bryan (2008), Exploring the cost effectiveness of land conservation auctions and payment policies, Aust J Agric and Res Econ 52(3):303-319.

Ferraro, P.J. (2008) Asymmetric information and contract design for payments for environmental services, Ecol Econ 65(5):810-821.

Fang, H., M.P. Keane and D. Silverman (2008) Sources of advantageous selection: evidence form the Medigap insurance market. J. Polit. Econ. 116:303-350.

Khanna, M. and A.W.Ando (2009) Science, economics and the design of agricultural conservation programmes in the US, J Envir Plan Manag 52(5):575-592.

Khanna, M., M.Isik and D.Zilberman (2002), Cost-effectiveness of alternative green payment policies for conservation technology adoption with heterogeneous land quality, Agric Econ 27(2):157-174.

Kleijn, D., F.Kohler, A.Baldi, P.Batary, E.D.Concepcion, Y.Clough, M.Diaz, D.Gabriel, A.Holzschuh, E.Knop, A.Kovacs, E.J.P.Marshall, T.Tscharantke, and J.Verhulst (2009), On the relationship between farmland biodiversity and land-use in Europe, Proc Roy Soc B-Biol Sci 276(1658):903-909

Laffont, J-J and D. Martimort (2002), The Theory of incentives – The Principal Agent Model, Princeton University Press.

Latacz-Lohmann, U. and C.P.C.M. Van der Hamsvoort (1997). Auctioning Conservation Contracts: a theoretical analysis and an application, Am J. Agric. Econ., 79:407-418.

Moxey, A., B.White and A.Ozanne (1999), Efficient contract design for agri-environmental policy, J Agric Econ, 50(2):187-202.

Quillerou, E., and R.Fraser (2010), Adverse selection in the Environmental Stewardship scheme: Does Higher Level Stewardship scheme design reduce adverse selection, J Agric Econ 61(2):369-380.

Quillerou,E., R.Fraser and I.Fraser (2011), Farmer compensation and its consequences for environmental benefit provision in the Higher Level Stewardship scheme, J Agric Econ 62(2): 330-339

Reidsma, P., T.Tekelenburg, M. van den Berg and R.Alkemade (2006) Impacts of land-use change on biodiversity: An assessment of agricultural biodiversity in the European Union, Agric Ecosys & Envir 114(1):86-102.

Russell,N. and J.Sauer (2011), On Self Selection in PES Schemes, May 2011, Agecon Search, University of Minnesota, http://ageconsearch.umn.edu/,

Stoate, C., N.D.Boatman, R.J.Borralho, C.R.Carvalho, G.R. de Snoo and P. Eden (2001), Ecological impacts of arable intensification in Europe, J Envir Manag 63(4):337-365

Strijker, D., F.J.Sijtsma and D.Wiersma (2000) Evaluation of nature conservation – An application to the Dutch Ecological Network, Env and Res Econ 16(4):363-378.

Waetzold, F. and M.Drechsler (2005), Spatially uniform versus spatially heterogeneous compensation payments for biodiversity-enhancing land-use measures, Env and Res Econ 31(1):73-93.

Wu, J. and B.A.Babcock (1996), Contract design for the purchase of environmental goods from agriculture, Am J Agric Econ 78(4):935-945.