

Report



Scoping the strengths and weaknesses of different auction and PES mechanisms for Countryside Stewardship

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Executive Summary

The majority of farmers in England currently receive a fixed fee for managing their land under an agri-environment scheme (Environmental Stewardship), which is based on an estimate of the typical income forgone by participating. The aim of this research is to explore alternative mechanisms for allocating agri-environment contracts with a view to achieving a more cost-efficient and effective use of funds. The focus is on reverse auctions, whereby farmers opt into a bidding process, offering to manage their land under prescribed management options at a price that more closely reflects their cost of doing so. The researchers have used a combination of laboratory experiments, simulation modelling and farmer workshops to consider the opportunity for efficiency gains, aspects of auction design and farmer responses to auctions.

A secondary objective of the work is to explore opportunities for the private sector to engage in agri-environment actions by leveraging match-funding where there are common goals and mutual benefits for private firms and society. This has entailed a review of the payment for ecosystem services (PES) literature and consultations with a number of relevant private firms. A particular focus for the latter has been the water companies, as they have already established some initiatives on PES around improving water quality.

Reverse Auctions as a mechanism for agri-environment schemes

A comprehensive review of payment mechanisms for agri-environment schemes was followed by detailed research on two auction models and a counterfactual fixed-price model. The options are:

- i. **Annual Budget-Constrained Auction:** Government seeks to maximise environmental improvement given a fixed budget with farmers asked to offer sealed bids to participate. Contracts are allocated on the basis of value for money (VFM)². Contracts are awarded to those offering the highest VFM, paying farmers what they bid, until the budget is exhausted.
- ii. **Target-Constrained Auction:** Government seeks to achieve a target level of uptake of a particular agri-environment activity in a particular region to deliver a landscape-scale impact. Farmers offer sealed bids on the basis of individual costs associated with the activity and the best VFM bids delivering the target are funded, with farmers being paid what they bid.
- iii. **Fixed-Price Mechanisms:** Government announces the amount that they will pay for particular agri-environment activity and receives offers from farmers prepared to undertake that activity at that price. If the scheme is over-subscribed, farmers are accepted into the scheme on the basis of VFM, starting with the highest VFM and continuing until the budget is exhausted. Broadly, this reflects the design of Countryside Stewardship.

Performance parameters were specified for evaluating these three mechanisms, namely effectiveness (goal achievement), cost-efficiency (environmental quality per pound spent) and social efficiency (environmental quality per pound actual cost). Key metrics used in the evaluation for these parameters include average VFM and rates of participation in the auction, including how these change over successive years of the auction being run.

The main findings of the experimental research and modelling are:

1. **An auction provides better cost-efficiency than an alternative scheme which offers a fixed price set around the centre of the cost distribution.** The simulation work suggests that a discriminatory price auction (where participants get paid what they bid) out-performs a

² Value for money (VFM) is calculated as quality score (as estimated by government) divided by bid cost (as submitted by the farmer).

uniform-price auction alternative in terms of VFM. This doesn't take account of the public costs of setting up an auction however and is sensitive to assumptions on the distribution of farmer costs.

2. **Providing feedback on the VFM of winning bids between successive years of agri-environment auctions encourages participation from farmers that are capable of offering good VFM bids.** In our simulation, feeding back on VFM leads to higher cost efficiency and higher social efficiency.
3. **Publication of guide prices has a modest impact over successive years of auctions but the primary benefit is in increased participation in the first year of the scheme.** Auction outcomes can be manipulated by the publication of guide prices but the impact erodes over successive years of auctions as information on the VFM of actual winners is fed back to participants.
4. **For multiple activities, a Pick and Mix auction format** (where farmers submit one bid for activity A and one bid for activity B and could be successful in none, one or both bids) **leads to better VFM than an All or Nothing format** (where farmers are forced to submit a single bid for either activity A, activity B or both activities A and B).
5. **In a landscape-scale target auction, the experimental evidence favours the use of a Follow-Up auction format.** This maintains sufficient competition to ensure bids are not inflated in the initial round while lowering the risks of low participation by holding out the possibility of a second round if the target is not initially achieved. The Follow-Up format appears to be robust to a number of different target auction settings.

The workshops highlight some potential challenges in persuading farmers that the auction approach can work in their favour but this is at least in part due to their familiarity with the current fixed price menu system which is not based on competition for agreements. As such it may be important to ensure the new Countryside Stewardship (CS) scheme is embedded before undertaking work on piloting auctions. Other than an aversion to change and the perceived complexity of bidding, farmers in the workshops offered a number of possible unintended consequences which government should consider in designing auctions for an agri-environment scheme, namely:

- Getting the right prices but the wrong farmers – not all have the same capacity to deliver an agreement well;
- Discounted bidding in order to secure an agreement but a subsequent perverse incentive to establish and manage options “on the cheap”;
- Uncertainty over securing a follow-on agreement may risk lower farmer participation and/or loss of prior environmental gains;
- A price-based system might favour larger landowners and contractors who have economies of scale and disadvantage small family farms.

Despite these reservations, farmers responded well to the auction exercise. Key findings include the value of access to information on previous successful bids in helping farmers to set their bid price and opportunities to encourage take up of ‘difficult’ options by bundling with other options to enhance scores. The findings of the experimental and simulation work are encouraging on these points.

Piloting reverse auctions for Countryside Stewardship

On the basis of the scoping work, significant potential benefits of the reverse auction approach have been identified in terms of value for money improvements that make the case for further research. Piloting auctions at a field scale is necessary in view of the need to test a range of design features that could affect the realisation of this benefit in practice and to provide further evidence on cost-efficiency.

We propose the following priorities for piloting reverse auctions for Countryside Stewardship funding in a Mid-Tier scheme:

1. A discriminatory price auction (where participants get paid what they bid). Within this the following elements should be explored:
 - a. provision of feedback
 - b. guide prices
 - c. Pick and Mix vs. All or Nothing format
2. A landscape-scale target auction, to include testing the use of a Follow-Up auction format.

We propose that the sample is drawn from farmers with existing Environmental Stewardship agreements insofar as they cannot enter Countryside Stewardship until their current scheme ends, but could participate in auction pilots using additional options available under the new scheme.

We recommend that three groups are captured in the pilots to represent the main farming systems and contexts, namely arable farms, lowland livestock farms and upland livestock farms. Within this framework, a range of options can be accommodated, focusing on a limited number of themes, for example to represent the key environmental priorities for CS, namely biodiversity and water quality. There would need to be some trade-off between the range of options considered and the size of the sample in order that the results are statistically robust.

A number of discrete steps in the establishment and running of pilots are envisaged as follows:

1. Agree the design options to be tested and target population
2. Recruit a statistically robust sample with at least 2 groups and at least 150 farmers per group.
3. Research the sample (cost distribution, transaction costs, capacity to participate etc.) prior to running in the pilot
4. Develop and trial a platform for operating the auction to ensure functionality and utility
5. Trial the auction design options. It may also be helpful to run the pilot over successive years to test learning.
6. Report the pilots and make recommendations on their use in agri-environment schemes.

As such we recommend that a phased approach is taken over a period of 2-3 years to provide robust evidence on the economic and environmental case for introducing reverse auctions as a delivery mechanism for Countryside Stewardship.

In order to measure the additional VFM from using auctions, it is necessary to compare against the standard CS approach (counterfactual). We recommend recruiting a sufficiently large sample to allow half to be randomly assigned to a fixed price group and half to an auction group.

Integrating public and private funding for PES

From discussions with a range of potential private funding agents, it is evident that they can be broadly considered in three groups according to their readiness to engage in Payment for Ecosystems Services (PES). The most engaged are the water companies, the 'PES Ready' group, with existing initiatives such as *Upstream Thinking* (South West Water) and *Catchment Wise* (United Utilities). The next group, the 'Investors in Ecosystem Services', are represented broadly by the food supply chain, who routinely work with land managers to improve productivity and sustainability but without a formal payment scheme. Finally, there is a group of private companies which have a vested interest in funding ecosystem service provision e.g. developers offsetting environmental losses associated with construction or insurance companies addressing flood risk at a catchment scale. For this study, our analysis has focused on the PES Ready group, namely the water companies.

A number of public/private models were considered for integrating Countryside Stewardship and water company schemes, namely:

- Co-ordinated but separate public and private schemes: Funds from water companies and Countryside Stewardship are channelled into targeted schemes, co-ordinated by catchment partnerships or trusted third party brokers.
- Joint administration of separate public and private schemes (through the public scheme): Water companies use the administrative apparatus of Countryside Stewardship and specify additional options that they would fund separately from the agri-environment funds. This model would provide a combined interface to farmers and could extend to a common monitoring and evaluation framework.
- Joint public/private purchasing (within the public scheme): Particular options co-funded by water companies and Countryside Stewardship under the governance of the latter. This might also include elements of joint administration.

A review of the opportunities for leveraging additional funding from the private sector to augment agri-environment budgets under PES indicates a good level of interest in involvement but multiple barriers in terms of design and implementation. For the water companies, there is some concern that current interventions (Environmental Stewardship options) are not comprehensive enough for addressing water quality issues at a local catchment scale. They also have concerns over losing contact and relationships with local land managers if their objectives were delivered under a single public scheme. A joint scheme would need to demonstrate to the regulator, Ofwat that catchment management schemes can deliver water quality improvements at least as cost effectively as engineering solutions.

For the public agency, EU funding rules require that management options are verifiable and controllable; this relates to payment rates, eligibility of the applicant and payment claims. A key issue is the payment rate for a management option, which is required to be no more than the additional costs and income foregone on a 'typical farm'. The lack of flexibility in payment rates and administration of public funding may be a real barrier to integration of schemes.

We conclude that co-ordination of purchasing through separate private and public schemes is the most promising model in the medium term as it secures the benefits of joined-up funding and activity without losing the flexibility required by the private agent and risking compromising EU funding rules. Governance models applied within existing water company initiatives such as *Upstream Thinking* and *Catchment Wise* provide a useful template. This includes a wide range of representation of public, private and third sector stakeholders and should be reciprocal in Countryside Stewardship. Some scoping work is needed to gauge the extent to which synergies can be realised in terms of option selection, data collection and scheme evaluation.

While delivering water quality objectives is tangible and location specific, for other potential PES stakeholders, such as the food supply chain, developers or insurance companies, the focus for investment is often more transitory e.g. due to the emergence of alternative options or to a change in business strategy, ownership, or fortunes. Nevertheless, these agents should be brought into the PES discussions to help scope and develop the possibility for integrated funding in their sectors. We propose that this might be through involvement on a PES panel which would observe the research on auction pilots and contribute to 2020 RDP design and wider policy.

Conclusions

The following conclusions are drawn from this study:

1. Laboratory experiments and simulation modelling indicate that a reverse auction approach to allocation of agri-environment agreements can provide increased competition and better cost-efficiency than an alternative scheme which offers a fixed price set around the centre of the cost distribution. The cost advantage is most pronounced when there is widespread participation in the scheme but was estimated at 15% in our simulation work. In the context of a funding pot of £3.1bn over the duration of the RDPE for all agri-environment and forestry schemes, this represents a significant potential gain.
2. In workshops, farmers participated in the auction exercise but were wary of competing for agri-environment agreements on a price-basis and highlighted a number of potential barriers to uptake of a reverse auction approach and design risks.
3. Pilots for reverse auctions on Countryside Stewardship should test the cost-efficiency of a discriminatory price auction (and a landscape-scale target auction) against a fixed price approach (counterfactual). To secure statistical robustness, we suggest that the sample should be at least 300 farms, randomly assigned to either an auction or a fixed price bidding approach.
4. The sample for pilots should comprise farmers with existing HLS agreements but offered additional CS options. It should be drawn from three discrete landscapes to represent arable farms, hill livestock farms and lowland livestock farms, testing relevant CS options for each context.
5. There are opportunities for leveraging increased funding for environmental land management through private PES but links to public schemes are currently very *ad hoc* with multiple barriers to bringing these together. Better coordination of private PES schemes with Countryside Stewardship would secure the benefits of joined-up funding and activity without losing the flexibility required by the private agent and/or the risk of compromising EU funding rules.
6. Potential private funders should be brought into public PES discussions to help scope and develop coordination of funding with Countryside Stewardship. We propose that this might be through involvement on a PES panel which would observe the research on auction pilots and contribute to post-2020 RDP design and wider policy. Immediate priorities include scoping and co-design of a model for public/private PES and developing a common framework for governance, operation and evaluation.

1 Introduction and objectives

1.1 Models of agri-environment delivery

The Common Agricultural Policy (CAP) provides public funding through the Rural Development Programme for England (RDPE) to safeguard and enhance the rural environment through agri-environment schemes (currently Environmental Stewardship), in addition to socio-economic schemes for farmers, foresters and rural communities. A new environmental land management scheme, 'Countryside Stewardship', will form part of the 2014-2020 RDPE. This will build on the existing Environmental Stewardship, Catchment Sensitive Farming and England Woodland Grant Schemes to introduce a universal scheme for both farmers and foresters, with a funding pot of £3.1bn over the duration of the RDPE for all agri-environment and forestry schemes.

This project considers two policy issues for the development of agri-environment policy. The first relates to opportunities to improve value for money (VFM) in terms of securing better environmental outcomes for a fixed budget and the second explores the scope to increase available funding through linking with the private sector where there is shared benefit from intervention. Both public and private schemes can be considered as models of Payments for Ecosystems (PES) but to date there has been limited progress in integrating funding or using novel mechanisms such as environmental auctions. Defra's Payments for Ecosystems (PES) Action Plan, (Defra, 2013), contained the following Government commitments:

“Explore the potential for different models of agri-environment delivery including reverse auctions and match-funding mechanisms, in the context of developing the new Rural Development Plan for England; and work with stakeholders to improve targeting and flexibility. Review the barriers and opportunities to incorporating private funding alongside Rural Development Programme funding.”

1.2 Project aims and objectives

This project is an exercise to:

- a) Investigate the potential for reverse auctions to deliver environmental outcomes through agri-environment and other RDPE environmental grant schemes; and,
- b) Review the barriers and opportunities to incorporating private combined-funding alongside agri-environment funding.

Specific objectives are:

1. Explore the potential for public-private combined-funding mechanisms and review the barriers to and opportunities for incorporating private funding alongside Rural Development Programme funding to achieve environmental improvements. Suggest ways of overcoming those barriers.
2. Assess the policy, practical and legal implications of different reverse auction designs within the context of the new Rural Development Programme for England. These should be focused on application within agri-environment schemes, including their ability to achieve scheme objectives cost-effectively.
3. Assess the potential for economic experiments to provide further evidence on the impacts of different auction designs, including an evaluation of their external validity. Propose a shortlist of at least six different auction designs to be investigated further through economic experiments, drawing on the environmental auctions literature. Design, run and evaluate experiments after consultation with Defra.

4. Drawing on Objectives 2 and 3, recommend several reverse auctions for Defra to trial on the ground within the new round of agri-environment schemes; and provide initial guidance on how these might be carried out and evaluated. Detailed implementation, however, is outside the scope of this project.

1.3 Methods

A number of discrete approaches were used to undertake this research. These are set out below and detailed in the annexes to this report.

Scope and design of reverse auctions

This work was led by Professor Brett Day at the University of East Anglia (UEA) and builds on their previous work on the design of reverse auctions. The main elements of the work were:

- i. A review of mechanisms for agri-environment schemes to scope and critique available models in the context of the architecture of the new agri-environment scheme in England (see annex 1)
- ii. Experimental auctions where groups of UEA students were asked to bid in a stylised version of an auction, to test single elements of the auction design. This comprised a total of 222 subjects over 14 sessions (see annex 2).
- iii. Simulation modelling to explore a budget-constrained auction scheme using assumptions on the impact of farmer decision-making on bidding behaviour and hence on the outcome of an auction (see annex 3).

The various elements of the work are brought together in Chapter 2 to provide an integrated assessment of the potential role of auctions in delivering agri-environment schemes and the particular findings on auction design which should be taken forward in any piloting work.

The experimental work was augmented by two farmer workshops – upland livestock and lowland arable – to assess practical issues around the use of auctions for allocating agri-environment funding (led by ADAS). These explored how farmers respond to the concept of an auction and to test bidding behaviour and the effect of some design elements in a practical context (reported in Chapter 3 and annex 4).

Opportunities for public-private funding of agri-environment schemes

This part of the project entailed a review of the literature on public and private PES and consultations with private firms that might be expected to engage with the PES principle (see annex 5). The work was led by Fera and focused on the water sector and a range of other stakeholders.

1.4 Report structure

The report is structured around the main work themes, starting with an exploration of the design options for reverse auctions that might be used for allocating funding in agri-environment schemes in chapter 2. This covers the scoping, experimental and modeling work undertaken by UEA and is supported by the detailed analysis in annexes 1-3. Chapter 3 sets out the key findings on how farmers might respond to auctions, based on the two farmer workshops run by ADAS and detailed at annex 4. Chapter 4 considers the evidence of engagement with PES from key private sector agents, notably water companies, which are detailed at annex 5. Chapter 5 builds on the scoping work on auction design for agri-environment schemes and provides proposals for piloting auctions during the course of the current 2014-2020 RDPE.

2 Reverse Auctions for agri-environment schemes

This research project's primary aim is to explore different mechanisms for allocating agri-environment contracts and to determine which mechanisms might best contribute to a more cost-efficient use of available funds. Efficiency in this context is defined as realising greater environmental improvements per pound of expenditure. The focus is not on the sorts of management activities that farmers might be asked to adopt under agri-environment schemes, but rather on the *economic mechanism* by which farmers are incentivised to participate in the scheme. In essence, that mechanism helps determine how farmers are selected into the scheme and how much each gets paid for the activities that they commit to undertake. There are very many possible mechanism designs, each presenting farmers with different incentives and each resulting in potentially very different outcomes. This research seeks to scope, review and test the most promising options.

In an extensive review (annex 1), we presented a detailed account of different possible designs of mechanism. While a great many possibilities were considered, discussion with the Steering Group narrowed the scope to a limited set of options. Those options concern a scheme in which the government offers to pay farmers to undertake agri-environment activities. The environmental improvement that each farmer might deliver from undertaking those activities is proxied by their environmental quality score, a score assigned to them by the government on the basis of environmental priority or potential. Since farmers differ in terms of the cost (foregone income) they will incur if they undertake the activity, a cost-efficient outcome will tend to direct contracts to low-cost, high-quality applicants. Within that general context, the project's scope is focussed on examining two auction mechanisms for allocating contracts and comparing those to a 'counterfactual' mechanism based on offering a fixed-price.

2.1 Economic mechanisms

Annual Budget-Constrained Auction

The first auction format envisages an auction with a fixed budget. Within that budget the objective is to secure contracts delivering as much environmental improvement as possible. The auction asks farmers to enter sealed bids with contracts being allocated on the basis of value for money (henceforth, VFM) calculated as a quality score divided by bid cost. The government awards contracts to those offering the highest VFM paying farmers what they bid up until the point at which the budget is exhausted.

As a precautionary measure the government fixes a minimum VFM reserve but does not reveal this to bidders. Bids that fail to achieve the reserve are not eligible for funding. The government also has the option of publicising a guide price which provides an indication of the level of bid that might achieve funding through the auction.

The auction is repeated each year with new entrants (including farmers whose previous agri-environment contracts have recently expired) ensuring no systematic changes in the characteristics of bidders over successive years. After an auction, the government has the option of making public the details of the bids and/or qualities of successful bidders.

Simple applications of this auction format consider a scheme for only one agri-environment activity. When the scheme asks farmers to consider undertaking two or more activities, a key design issue concerns the format in which the government accepts bids. In an 'All-or-Nothing' format, farmers enter just one bid which describes the payment they require in order to undertake the set of activities they have selected. In contrast, in a 'Pick-and-Mix' format farmers enter a separate bid for each activity and the government decides which of those offers to accept.

Target-Constrained Auction

In the second auction format, farmers in a particular region are informed that the government is seeking to achieve a target level of uptake of a particular agri-environment activity. As in the budget-constrained auction, farmers differ in their costs in delivering that activity and are assigned an environmental quality score by the government. The government requests bids in the form of sealed bids. The best VFM bids delivering the target are funded, with farmers being paid what they bid.

The auction has a reserve VFM in order to guard against the possibility that farmers may seek to exploit the lack of a budget constraint by entering highly inflated bids. The reserve VFM is not revealed to farmers. If too few eligible bids are received such that the target is not reached, the auction is deemed to have failed and no one receives funding.

The possibility exists for running the target auction with two bidding periods, with information on bids received in the first period being publicised before the second and final bidding period opens. Alternatively, following an auction failure the scheme may allow for one additional rerun of the target-constrained auction in the following year.

Fixed-Price Mechanisms

Instead of an auction, agri-environment contracts could be allocated using a fixed price mechanism. In that case, the government announces the amount that they will pay and receives offers from farmers prepared to undertake the agri-environment activity at that price. If the scheme is over-subscribed then the government chooses to fund only those farmers offering the highest VFM up until the point at which the budget is exhausted. This is broadly the design of the middle-tier of Countryside Stewardship.

The central design question for a fixed-price mechanism is where to set the level of the fixed price. If the objective is to maximise environmental benefits, then that price would be set at the uniform payment that returns the greatest environmental quality for the given budget. Unfortunately, identification of this optimal fixed price requires accurate knowledge of bidders' true costs, knowledge that will not be available to the government.

In reality, it seems more likely that the government will adopt a simpler rule in setting fixed prices. In particular, the Steering Group indicated that the alternative fixed price scheme for this project should be based on the mean or median of the assumed distribution of costs across farmers. This is broadly how payments for agri-environment options are set now. As a result, as a point of comparison with the auction outcomes, we examine an alternative scheme offering a fixed price set at the median of the distribution of costs.

2.2 Evaluating Auctions

There are several ways to evaluate the performance of a funding allocation mechanism. We describe those measures here before applying them in assessing the performance of the various auction formats.

Goal Achievement

A first criterion concerns whether the auction achieves its basic goal. In the case of a budget-constrained auction, the basic goal is to spend the budget. Likewise, in a target-constrained auction the goal is to receive enough eligible bids to achieve the target. Importantly, in comparing outcomes across formats, it is only valid to compare formats which achieve the same basic goal.

Cost Efficiency

From the point of view of the buyer, one useful measure of performance is cost efficiency. In this case, that measure is calculated as the environmental quality purchased through the auction divided by the money spent. Accordingly, cost efficiency is measured in points per pound. Clearly, formats that deliver higher cost efficiency are preferred by the buyer.

Social Efficiency

From society's point of view (as opposed to that of the buyer) the key issue is not how much is spent in delivering environmental quality, but the quantity of real costs that are incurred. For society, payments to farmers above their costs are simply a transfer of money from one member of society to another; nothing is lost to society in making that transfer. In contrast, the cost of foregone agricultural output and participation costs represent real losses to society. While the buyer worries about how much money they must spend per unit of environmental quality purchased, society worries about how much real cost it incurs per unit of environmental quality. We describe this as measuring the social efficiency of the auction.

Like cost efficiency, social efficiency is measured in points per £. The calculation involves dividing the environmental quality purchased through the auction by the social costs incurred in that auction, where social costs are the sum of normal incomes (opportunity costs) foregone by farmers that are successful in the auction plus the sum of participation costs (transaction costs) of all those that bid in the auction.

Comparison to a Fixed-Price Scheme

One objective of the project is to assess auction outcomes in comparison to an alternative fixed-price scheme. As we have already discussed a key issue in making that comparison will be the level of fixed price used in that alternative scheme. In addition, it is important to note that comparisons between auctions and fixed-priced alternatives are highly sensitive to the particular distribution of farmers' opportunity costs. As we shall demonstrate, certain distributions of costs will tend to make fixed-price schemes look relatively poor in comparison to auctions, other distributions the reverse.

One other possible point of difference between an auction and a fixed price scheme concerns transaction costs: in particular, costs incurred by the government in the administration of the scheme and costs incurred by farmers in entering an application in the scheme. In our testing we explore what difference it makes to the relative performance of the two schemes when we assume that the costs of farmers applying for funding are half as large in the fixed price scheme as they are in an auction. In this work we do not examine differences in the costs of administering the two different schemes.

2.3 Testing Methodology

The outcomes of agri-environment schemes are undoubtedly dependent on a great many factors; some environmental, some economic, some social, and even some that are purely random. Within the context of a relatively small scale research project, it is clearly impossible to develop a testing methodology that can reflect that incredible complexity. And we make no pretence that that is what we achieve here. Rather the purpose of this research project is to provide the foundational evidence upon which further decisions to progress with more extensive testing might be made.

In this chapter we focus primarily on economic factors; that is to say, we explore the performance of auctions when the individuals in those auctions are likely to make their decisions based on rational logic. Of course, real decisions may not be strictly rational. All the same, it makes a lot of sense to begin an exploration of auctions making the rationality assumption; if an auction fails to deliver any advantages under the assumption of rationality it is almost certainly going to perform poorly in the more complex context of real-world decision making. Moreover, the testing methodologies available to us to explore rational decision-making are relatively inexpensive so that we can examine a number of different designs of auction to establish which designs, if any, have favourable properties.

The testing methodologies we employ in that pursuit are laboratory experiments and simulation modelling. As explained in detail subsequently, laboratory experiments mimic the incentives of real agri-environment auctions by offering groups of subjects' money rewards for participating in simplified

simulations of those auctions. Simulation modelling, on the other hand, replaces farmers with interacting computer programs to examine how different designs of auctions might play out.

In the next chapter, we move to a second level of testing in which we ask farmers to consider the pros and cons of different auction designs. And in the final chapter we suggest designs for real field pilots of auctions.

2.3.1 Laboratory Experiments

In a laboratory experiment, groups of subjects are asked to bid in a stylised version of an auction. While stylised, the basic incentive properties of the experimental auction are the same as those in a real world auction; the amount of money subjects get paid for participating in the experiment depends on whether their bid is accepted and the degree to which that bid exceeds their cost.

Laboratory experiments cannot replicate the diversity and complexity of the real world. Indeed, the strength of this testing tool is not in recreating realism, but in simplifying reality in such a way that the impact of discrete options for a single element of the design of an auction can be unambiguously compared. To be specific, different samples of subjects play out the same basic auction, changing one element of auction design at a time. Comparison across samples affords insights as to the impact of different options on auction outcomes. A detailed description of the experimental procedures and further analysis of the experimental data can be found in annex 2 of this report.

Experimental Design

In the experiments, groups of 16 subjects recruited from the University of East Anglia student population competed in a series of auctions executed through a computer program. Each subject was told that they had farmland that could earn them a certain *normal income*. Subjects were informed that instead of earning their normal income, they could rent out their land in return for a payment that they requested in the form of a bid in an auction.

A number of different auction formats were trialled in the experiments. Indeed, the 16 subjects in each experimental session participated in 6 different tasks where each task was an auction of a different format. In each auction, bids were evaluated on the basis of VFM. Each farm was allocated a *quality score* and VFM was calculated by dividing that quality score by the rental request a subject made in their bid. Subjects (farmers) were not informed of the quality score or normal income of any other farmer. In each auction bids offering the best VFM were approved up to the point at which either a budget was exhausted or a target number of bids accepted.

By entering a bid in an auction, subjects incurred a participation cost that they paid whether their bid was successful or not. Accordingly, for subjects that felt they had a low chance of success, a reasonable strategy was not to bid so as to avoid the participation cost.

As shown in Table 1, the normal incomes and quality scores for each farm were carefully chosen so as to identify four farm types defined by having (1) either a high or low normal income and (2) either a high or low quality score.³ In each task 4 of the 16 subjects were randomly allotted to each type.

³ To avoid making this very obvious to participants, both normal income and quality score were made to vary slightly around the average Low and High levels.

Table 1: Characteristics of Different Farm Types

| Type | Normal Income (£) | Quality Score (pts) | Quality-for-Cost (pts/£) | Competitiveness |
|------|-------------------|---------------------|--------------------------|-----------------|
| LH | Low | High | High | High |
| HH | High | High | Medium | Medium-High |
| LL | Low | Low | Medium | Medium-Low |
| HL | High | Low | Low | Low |

Notice from the fourth column of Table 1 that farms with low normal incomes and high quality scores (Type LH) possess high *quality-for-cost*. Quality-for-cost is calculated as a farm's quality score divided by the cost the farmer incurs in delivering that quality in the agri-environment scheme (their foregone income). Clearly, a farmer with high quality-for-cost is capable of offering bids that deliver high VFM and hence is likely to be highly competitive in an auction (column 5). In contrast, farms with a high normal income and a low quality score (Type HL) possess low quality-for-cost and, as such are likely to be least competitive in the auction.

The HH types and LL types in the experiment were constructed such that they had identical quality-for-cost. All the same, the high level of environmental quality enjoyed by HH gives them a competitive advantage over LL types. In particular, a marginal increase in the bid of a HH type reduces the VRM of their bid relatively less than for an LL type. For example, an HH type with quality 100 who bids £100 would offer a VFM of 1. Likewise an LL type with quality 10 who bids £10 would also offer a VFM of 1. If the HH type puts their bid up by £1, their VFM falls to 0.99. In contrast, if the LL type puts their bid up by £1 their VFM falls to 0.91.

2.3.2 Testing Methodology: Simulation Environment

The simulation environment developed for this project is a sophisticated piece of software that attempts to replicate the behaviour of multiple interacting farmers when participating in a mechanism allocating agri-environment contracts. The simulator consists of a series of subprograms, each representing a unique individual farmer with their own unique farm. Each farmer makes their own decisions following logic that can be more or less sophisticated depending on the farmer. Farmer's decisions are guided by their own circumstances but also by what they initially know about the other farmers and what they learn about other farmers' behaviour during the course of the simulation. Faced with a particular auction design, the simulator allows us to explore how participation and bidding behaviour differs across farmers and how that behaviour evolves as the auction is repeated over subsequent years. Indeed, it allows us to compare outcomes for different designs of auction and contrast those to a fixed price mechanism for allocating agri-environment contracts.

In a simulation environment, everything is coded by the analyst. In our case, that means the analyst selects the number of farmers, each farmer's costs from participating in an agri-environment scheme and the benefits each farmer can offer through their participation. The analyst decides on the reasoning each farmer uses in deciding how to bid and also decides how farmers change that reasoning when given decision-relevant information. A detailed description of the logic and algorithms of the auction simulator is provided in annex 3. Here we provide a brief guide to the key elements of its design and logic.

Calibration of Costs and Quality

One of the key issues in constructing the simulation environment is making sensible decisions regarding how the opportunity costs of undertaking an agri-environment activity are distributed across farmers. On the advice of the Steering Group, we make the assumption that the activities to be undertaken in the agri-environment scheme require a farmer to take 1 hectare of land out of production. The Steering Group provided us with data from the Farm Business Survey that recorded the distribution of farm gross margins (GM) per hectare for 2013. Having adjusted the data to remove the influence of the very high returns realised in horticulture, a sample of 1,000 GMs per hectare were drawn at random from the resultant distribution. Each of those GMs per hectare was taken to be the foregone income of a farm in our simulation. Of course, when participating in an agri-environment scheme, fluctuations in yields and market conditions mean that farmers are uncertain as to the actual levels of income they will forego by participating in the scheme. Accordingly, we used data published by DEFRA (DEFRA, 2014) to calculate the average annual percentage change in GMs across the period 2011 to 2014 and for each farm constructed two further possible foregone income quantities that were this percentage higher and lower than the foregone income derived from the 2013 data.

Unfortunately, information on the distribution of quality scores to be used in any future English agri-environment scheme is not currently available. Accordingly, we simulated quality scores as random draws from a probability distribution centred on 100 and with a range of 100. The simulation code allows us to allocate those quality scores to farms at random, or in such a way that cost and quality show positive or negative correlation. Annex 3 includes an exploration of the effect of different forms of cost-quality correlation on the outcome of auctions.

Risk Aversion

The basic assumption in the auction simulator is that each farmer knows their own quality score and has three possible estimates of what their GM might be in the future. We assume that a farmer uses those estimates to calculate their expected foregone income from participating in the agri-environment scheme. The greater their level of risk aversion, the more weight they put on low gross margins in calculating that expected cost from participation, as the agri-environment scheme offers a guaranteed payment. Again in annex 3 we explore the impacts of changing levels of risk aversion on bidding behaviour, and justify from the literature and from our own analyses the decision to assume that farmers are moderately risk averse in their bidding behaviour.

Prior Information

Farmers' bidding behaviour is shaped by the prior information they hold on the costs and qualities of other farms. In the simulator we assume that each farmer has imperfect knowledge of those details only for a relatively small subsample of other farms. If a farmer's prior information is based on an exact representative sample of all farmers then it will provide them with an unbiased assessment of the cost and quality distribution. Alternatively, and possibly more likely, it may be based on a biased sample that we suspect will be made up of other farms that have costs and qualities relatively more like their own.

In annex 3 we explore the impact of changing the accuracy of prior information. Note that the analyses reported in this summary assume that farmers suppose that other farms are more similar to theirs than they are in reality. Allowing for such bias reflects our expectation that farmers will know relatively more about the costs and qualities of farms in their local region which are likely to be more like their own. Such bias tends to reduce bids from farms with high quality-for-cost. For example, consider a low cost, high quality farmer who believes that other farms resemble their own more than is the case in reality. Under that misapprehension, such a farmer assumes that the bidding environment is highly competitive and, therefore, tenders a relatively competitive bid themselves. Accordingly, the simulation results suggest that increasing prior bias will lead to lower bids amongst relatively competitive farmers.

Bidding Logic

In deciding how to bid, the simulator assumes that there are progressively more sophisticated levels of logic that farmers can use in deciding upon how much to ask for as a payment in the auction. Farmers employing the first level of bidding sophistication only consider their own circumstances. They decide upon a percentage mark-up that they feel represents a suitable recompense for joining the agri-environment scheme and enter a bid amounting to their costs plus this mark-up. To arrive at that amount in our simulator we randomly allocate each farmer a mark-up on the range 5% to 25%.

Farmers employing the second level of sophistication go one step further and consider how their chances of winning might be affected by other farmers' bids. In particular, using their assumed level of suitable mark-up, a farmer calculates the bids that they anticipate the other farmers in their prior information might enter in the auction if those other farmers only used the first level of bidding sophistication. Looking at the distribution of those bids and considering the amount of money in the scheme budget, a farmer using the second level of sophistication chooses a bid that maximises their expected earnings given their level of risk aversion.

Of course, a farmer might go one step further and employ a third level of bidding sophistication. In this case, they would assume that each farmer in their prior information set decided on a bid using the second level of bidding sophistication. Reasoning out those other bids, a farmer would again arrive at a bid distribution and formulate their own bid as a best response. And so on through increasing rounds of sophistication.

We investigate the impact of different assumptions regarding bidding logic sophistication in annex 3. In the results reported here, we assume that different farmers employ different levels of bidding sophistication. We randomly assign each farmer to a particular level such that roughly 15% of farmers use one level of bidding sophistication, 50% use two or three levels of bidding sophistication and 35% use four or more levels of bidding sophistication.

Response to Information: Guide Prices and Feedback

Different formats of auction provide farmers with various forms of decision-relevant information. For example, some auction formats may provide a guide price. We assume that farmers interpret this guide price as the government's estimate as to the level of the marginal bid; that is to say, the sort of bid that will just achieve funding. In the simulator, farmers compare the guide price with their expectation of the level of successful bids. If there is a big difference between the two, then a farmer makes adjustments to their prior information set to make the farms in it look more like those that would be compatible with the stated guide price. We assume that farmers treat prior information and the guide price about equally when considering bidding.

Similarly, after the first year of the auction, the government may provide feedback on the bids, qualities or VFMs of successful bids. Again farmers bidding in the subsequent year take note of this information in forming their bids. Indeed, we assume that they make adjustments to their prior information set to make it look like a distribution of farms that would have resulted in the observed details of winning bids. Unlike the guide price, this is real data such that we assume that farmers attach full consideration to this information in considering how to bid. When farmers are provided with details of the VFMs of winners from the previous auction, they are able to observe the level of the lowest VFM that successfully secured funding. In this case, we also assume that farmers suppose that neither they nor any other farmer would bother bidding in the next auction if they couldn't offer that level of VFM. Again we explore the implications of that assumption in annex 3.

In the analyses that follow, we examine how the different forms of feedback (i.e. feedback on bids, qualities or VFM) impact on bidding behaviour. For convenience and to simplify comparison across years

(and on the advice of the steering group), we assume that the set of farmers participating in each year's auction have identical characteristics to those that participated in the previous year. We also assume that farmers in our simulation know that to be the case.

2.4 Budget-Constrained Auctions

Our first set of analyses draw on the simulation environment and laboratory experiments in order to explore design elements in a budget-constrained auction. For these auctions, the budget in the experiments and simulations was set such that around a third of participants would be awarded contracts in each of the five years of auctions. Moreover, for the purposes of simplicity and clarity, the majority of our analyses consider a scheme looking to contract farmers to undertake a single agri-environment activity. Only later do we consider the more complex case in which the scheme offers farmers the opportunity to undertake one or both of two different activities.

While the extended reports provide a comprehensive analysis of the research findings, for the purposes of this summary we focus on two key elements of the auction design; the provision of information feedback and guide prices.

2.4.1 Information Feedback

Full Information Feedback

We begin our discussion by considering how bidding in an auction is impacted by different forms of feedback provided to farmers on the successful bids from the previous year's auction. Our base case is a scheme in which the VFMs of winning bids are publicised by the government. Since the quality of bids is judged on the basis of VFM, learning the VFM of winning bids is strategically useful information for farmers; it allows them to consider how they should adjust their bid to ensure that they offer a VFM that has a chance of success. Subsequently, we shall compare that scheme to one in which only restricted information is provided either on just the level of payment requested by winning bidders or just on the number of quality points offered by winning bidders.

Figure 1 provides a graphical illustration of data from the auction simulator. The data describe the simulated outcome of 5 consecutive years of auctions in which the VFM of winning bids is publicised after each auction.

To understand Figure 1, note that it plots out information for each farmer, organising those farmers from left to right in order of declining quality-for-cost. Remember quality-for-cost is calculated by dividing a farmer's quality score by their foregone income. Farmers to the left of the plot are those with the highest quality-for-cost and are those who have the potential to offer the highest VFM bids. Moving to the right, the quality-for-cost of each successive farmer declines, such that those farmers are progressively less well-positioned to enter high VFM bids.

In this simulation, foregone income and quality are not correlated such that those capable of offering the best VFM will also tend to be those that have the lowest costs. That relationship is shown by the black line in Figure 1; costs tend to be lowest for farmers with high quality-for-cost but rise as quality-for-cost declines⁴

⁴ The cost line in this Figure is actually a 'smooth' (as are all the lines in this and subsequent Figures); that is to say, it gives the average foregone income for farmers around each level of quality-for-cost

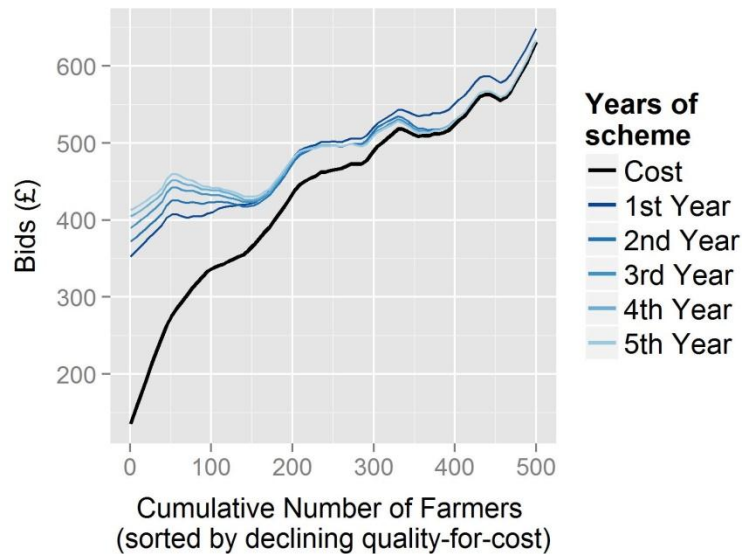


Figure 1: Bidding behaviour in a sequence of auctions with VFM feedback between auctions

The blue lines in Figure 1 illustrate the bidding behaviour of farmers for each of the five years of the auction. Recall that the budget in the auction is such that around a third of the 1,000 simulated farmers might be awarded an agri-environment contract. Since those with low quality-for-cost have very little chance of being successful in the auction, Figure 1 is truncated at the farmer with the 500th lowest quality-for-cost.

Figure 1 shows that bidding behaviour changes with relative competitive advantage. In particular, high quality-for-cost farmers enter bids that are significantly higher than their costs but the degree of shading in bids (that is, the degree to which a bid exceeds costs) declines for farmers with progressively lower quality-for-cost.

Also observe that patterns of bidding change over successive rounds of the auction. Recall that in this simulation farmers' prior information sets are biased, leading them to believe that other farmers have costs and qualities more like their own. Accordingly, before receiving auction feedback, a farmer with high quality-for-cost initially believes conditions to be more competitive than they are in reality. The revelation of the VFMs of winning bids allows high quality-for-cost farmers to form a better estimate of their chances of success in the auction. As such we observe those farmers entering progressively higher bids (that offer lower VFM) over successive years of the auction. In Figure 1, therefore, for farmers to the left of the plot with high quality-for-cost the blue lines showing levels of bids in each year of the auction trend up year on year.

The opposite pattern is observable for those with relatively lower quality-for-cost. Believing other farmers to have quality-for-cost scores somewhat similar to their own, those farmers initially assume that they have a reasonable chance of winning. Their bids in the first year's auction contain an element of shading; that is to say, they bid at a level somewhat higher than their costs. Once details of the VFM of successful bidders are revealed, farmers with relatively low quality-for-cost revise their assumptions regarding their chances of winning downwards. As such, in subsequent years' auctions we observe these farmers entering relatively lower bids, bids that offer higher VFM. From Figure 1 it is clear that for farmers towards the right hand side of the plot, bids after the first year's auction decline to a level that is only just above their costs.

The overall pattern, therefore, is one in which those farmers with the highest quality-for-cost tend to increase their bids over successive years of auctions while those with lower quality-for-cost tend to drop their bids. The 'pivot' point between these two behaviours is somewhere around the farmer with the

200th highest quality-for-cost. And, given only about a third of the 1,000 simulated farmers can be funded from the budget, after the first year's auction farmers beyond the 400th highest quality-for-cost realise they have little chance of winning and so enter bids that are little different from their costs. Note that, so far, we are assuming that there are no transaction costs associated with bidding in the auction, so it always makes sense to enter a bid that at least covers costs.

Numerical details of the auctions illustrated in Figure 1 are recorded in Table 2. The rows of the table record outcomes from the auction in each successive year of the scheme. The first column lists the number of farmers entering a bid in the auction. Since there are no transaction costs in this simulation, it always makes sense to bid such that we see 100% participation in each of the five auctions. The second column lists the number of farmers who were successful in the auction and were awarded an agri-environment contract. The third column details the total payments made to those successful farmers. For these auctions the budget is around £153,500 and in each year this budget is essentially fully spent. The fourth column describes the total social costs resulting from the scheme. Since transaction costs for participating in the auction are zero, this total is simply the sum of foregone incomes of the farmers that are awarded contracts.⁵ The fifth column lists the total number of quality points provided by the farmers that are awarded contracts. Finally, the last two columns provide key measures for evaluating auction performance; cost efficiency and social efficiency. As previously explained, cost efficiency is calculated by dividing the total quality delivered by the auction by the expense the government incurs in purchasing that quality. Social efficiency, on the other hand, is calculated by dividing total quality by the real costs incurred by farmers through the scheme.

Table 2: Auction outcomes in a sequence of auctions with VFM feedback between auctions

| Year of Scheme | Participation | Num. Awards | Total Payments (£s) | Total Social Costs (£s) | Total Quality (pts) | Cost Efficiency ¹ (£s/pt) | Social Efficiency ² (£s/pt) |
|----------------|---------------|-------------|---------------------|-------------------------|---------------------|--------------------------------------|--|
| One | 100% | 334 | 153,821 | 131,078 | 40,372 | 0.263 | 0.308 |
| Two | 100% | 339 | 153,554 | 127,540 | 39,920 | 0.260 | 0.313 |
| Three | 100% | 336 | 153,485 | 125,216 | 39,443 | 0.257 | 0.315 |
| Four | 100% | 334 | 153,441 | 123,889 | 39,149 | 0.255 | 0.316 |
| Five | 100% | 332 | 153,227 | 122,628 | 38,873 | 0.254 | 0.317 |

Notes: ¹ Calculated as total quality divided by total payments; ² Calculated as total quality divided by total social costs

Observe from Table 2 that cost efficiency declines over successive years of the auction, such that the auction is 3.5% less cost-efficient in the fifth year than in the first year. That pattern reflects the aggregate of behaviours working in opposing directions. On the one hand, cost-efficiency is inflated over successive auctions through lower quality-for-cost farmers reducing their bids. On the other, cost-efficiency is reduced by high quality-for-cost farmers increasing their bids. Overall, the latter effect outweighs the former such that overall levels of cost-efficiency decline over successive auctions.

In contrast social cost efficiency increases over successive years of the auction; the auction in the fifth year is 3% more socially efficient than in the first. Feedback on the VFM of successful bids allows farmers to better judge their relative competitiveness in the auction. As a result, those with high quality-for-cost learn to bid so as to successfully out-compete those with relatively lower quality-for-cost. This learning

⁵ Note that we also ignore costs incurred by the government in administering the auction.

ensures that over successive auctions, awards are concentrated in the hands of those that can deliver the most quality at the least foregone income.

Partial Information Feedback

Rather than informing farmers of the VFM of previous winners, the government might attempt to conceal some of the strategically relevant information by only releasing details of the payments asked for in the bids made by successful farmers. The outcome of a series of five years of auctions in which only this payment information is released between auctions is provided in the middle panel of Figure 2. Figure 1, documenting bidding behaviour in an auction with VFM feedback, is reproduced in the left hand panel for the purposes of easy comparison.

As with providing VFM feedback, releasing payment information is useful to future auction participants since it allows them to identify the levels of bid that have previously proved successful. For example, if those payments are markedly lower than a farmer had expected, then that farmer can adjust their bid down in order to increase their chances of success in a subsequent auction. Of course, without also knowing the environmental quality of previous winners, farmers still cannot gauge the level of VFM offered by winners in the last auction. Accordingly, they are still relatively poorly informed as to the level of payment they should request so as to ensure that their bid has a competitive chance in the auction.

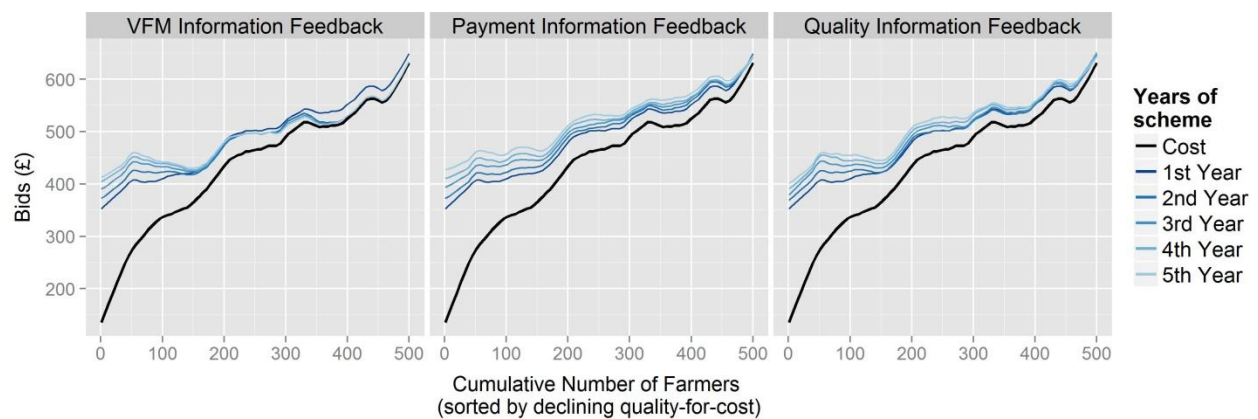


Figure 2: Bidding behaviour under different forms of feedback on winning bids

That lack of certainty is reflected in the rather different patterns of bidding shown in the middle panel of Figure 2. While, similar to VFM feedback, farmers with the highest quality-for-cost tend to increase their bids over successive years of auctions, payment feedback does not induce lower quality-for-cost farmers to drop their bids. Instead, these farmers' bids, encouraged by the appearance of some relatively high payments amongst the previous auction's successful bids, tend to edge up over successive auctions. As shown in the middle columns of Table 3, that different pattern of bidding means that cost-efficiency declines more rapidly and further over successive rounds of an auction with payment feedback than it does in an auction with VFM feedback.

The rightmost panel of Figure 2 illustrates bidding behaviour when feedback is limited to revealing just the environmental quality scores of winners of previous auctions. In addition to knowing the quality scores of winners, farmers provided with this information can work out approximately how much each got paid by dividing the auction budget by the number of winners. To that extent, feedback on quality scores provides auction participants with somewhat more information than feedback just on payments. All the same, from Figure 2 and Table 3, we observe that bidding patterns across successive auctions with quality feedback is very similar to that with payment feedback and that both perform less well in

terms of cost-efficiency and social-efficiency than an auction with VFM feedback, particularly in later years' auctions.

Table 3: Auction outcomes under different forms of feedback on winning bids

| Year of Scheme | Feedback | | | | | | | | |
|----------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|
| | Winning VFM | | | Winning Qualities | | | Winning Payments | | |
| | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ |
| One | 100% | 0.263 | 0.308 | 100% | 0.263 | 0.308 | 100% | 0.263 | 0.308 |
| Two | 100% | 0.260 | 0.313 | 100% | 0.259 | 0.307 | 100% | 0.259 | 0.312 |
| Three | 100% | 0.257 | 0.315 | 100% | 0.255 | 0.307 | 100% | 0.255 | 0.312 |
| Four | 100% | 0.255 | 0.316 | 100% | 0.253 | 0.307 | 100% | 0.251 | 0.313 |
| Five | 100% | 0.254 | 0.317 | 100% | 0.249 | 0.304 | 100% | 0.249 | 0.313 |

Notes: ¹ Participation rate in percent; ² Cost efficiency calculated as quality points per £ of govt. expenditure on contracts; ³ Social efficiency calculated as quality points per £ of farmer costs through taking on a contract

Our interim conclusion, therefore, is that the simulation evidence favours VFM feedback over auction formats that restrict feedback to just the payment or quality of winning bids. We proceed by investigating whether that conclusion continues to hold as more realism is introduced to the simulation.

Transaction Costs

Thus far we have assumed that farmers' only cost in winning a contract is the income they forego through undertaking the agri-environment activity. In reality, of course, farmers may incur costs just through the action of applying for funding through the scheme. There is some evidence that such costs are not insubstantial, for example, Mettepenningen et al. (2009) estimate transaction costs of this nature to be around £20 per ha for farms participating in European agri-environment schemes. Importantly, the existence of such transaction costs may deter farmers from even applying for funding through the scheme.

Figure 3 illustrates the bidding behaviour of those that choose to participate in the auction at three different levels of transaction cost, with the medium cost being our best estimate of £20. Note that all three of these simulated auctions provide VFM feedback on previous winners.

The first thing to note from Figure 3 is that the existence of transaction costs shifts bids upwards compared to Figure 2; farmers seek to cover not only their foregone income from lost agricultural output but also the transaction cost of participating in the scheme. Accordingly bids with a £50 transaction cost tend to be higher than those with a £20 transaction cost which in turn tend to be bigger than those with a £5 transaction cost. Besides that, the pattern of bidding across successive auctions looks somewhat similar to what we saw before; bids, particularly those from high quality-for-cost farmers, tend to increase over auctions as feedback allows them to discover about their relative competitive advantage.

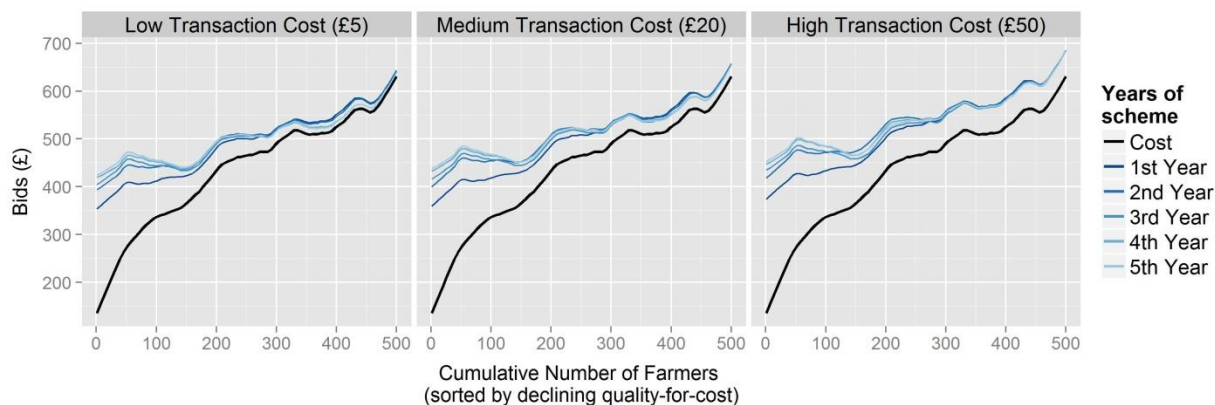


Figure 3: Bidding behaviour under different assumptions regarding transaction costs

Table 4 summarises the outcome of the auctions graphed in Figure 3. Given the pattern of increasing bids seen in the graphs, we might expect a steady decline in the cost efficiency of the auction. In fact, at all three levels of transaction cost we observe something somewhat different: between the first auction and the second, cost efficiency steps up before declining over subsequent auctions. The initial jump in cost efficiency is mirrored by a similar increase in social efficiency. And in all three cases we then observe social efficiency tending to increase over the subsequent years' auctions.

Table 4: Auction outcomes under different assumptions regarding transaction costs

| Year of Scheme | Transaction Costs | | | | | | | | |
|----------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|
| | £5 | | | £20 | | | £50 | | |
| | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ |
| One | 47.0% | 0.248 | 0.298 | 40.1% | 0.235 | 0.278 | 35.3% | 0.216 | 0.246 |
| Two | 48.1% | 0.250 | 0.310 | 44.5% | 0.243 | 0.297 | 40.2% | 0.232 | 0.272 |
| Three | 42.7% | 0.249 | 0.311 | 40.5% | 0.242 | 0.297 | 36.2% | 0.226 | 0.267 |
| Four | 43.6% | 0.247 | 0.313 | 42.0% | 0.240 | 0.299 | 38.6% | 0.229 | 0.273 |
| Five | 42.7% | 0.246 | 0.314 | 41.0% | 0.240 | 0.300 | 37.5% | 0.227 | 0.272 |

Notes: ¹ Participation rate in percent; ² Cost efficiency calculated as quality points per £ of govt. expenditure on contracts; ³ Social efficiency calculated as quality points per £ of farmer costs through taking on a contract

To understand the seeming inconsistency between the graphs and the table data, observe Figure 4. This figure plots out the proportion of farmers at each point on the quality-for-cost distribution that choose to participate in the auction.

Concentrate first on the data recording participation in the first year's auction given by the dark blue line. Not surprisingly, all high quality-for-cost farmers enter bids. In contrast, an increasing proportion of farmers with progressively lower quality-for-cost choose not to bid in the scheme: the lower a farmer's quality-for-cost the less competitive they are in the auction and the more chance their bid will be rejected. Of course, with a transaction cost, having a bid rejected leaves a farmer worse off than if they had not entered a bid at all. Accordingly, the fact that the lines on the graph fall from left to right reflects the fact that a farmer's bid is more likely to fail and therefore they are more likely not to participate in the first place.

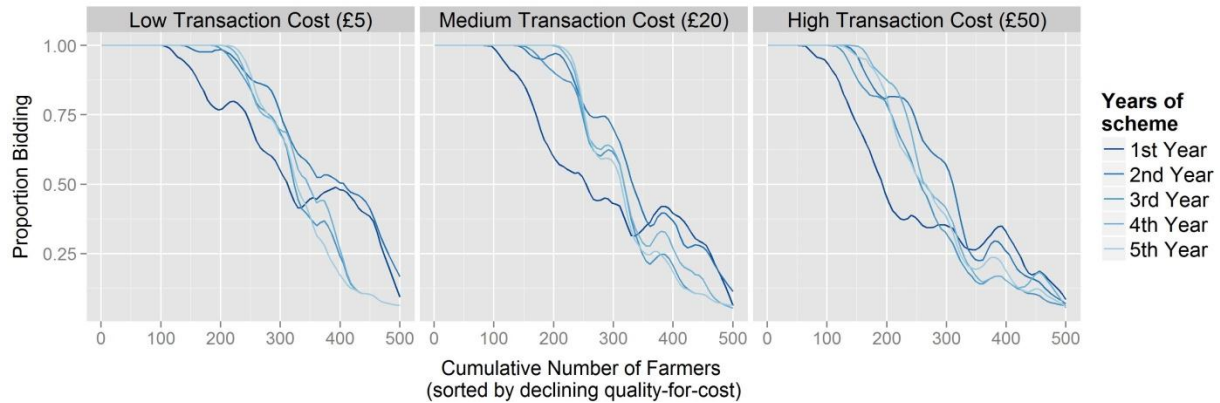


Figure 4: Proportion of farmers participating in the auction under different assumptions regarding transaction costs

Also apparent in Figure 4 is the fact that, for any particular level of quality-for-cost, as transaction costs increase, participation in the first year's auction falls. Again, the higher the transaction costs the larger the risks of failure and the more likely it is that farmers will not participate in the auction.

Now consider how rates of participation change as we progress through successive years of the auction. Observe that for all three levels of transaction cost participation rates amongst those with high quality-for-cost increase markedly after the first year, while those with relatively low quality-for-cost tend to fall. The 'pivot' point in all cases is around the 333rd highest quality-for-cost farmer. Clearly that pattern of changing participation over successive auctions reflects the provision of information feedback.

All farmers begin with a biased prior-information set, but for high quality-for-cost farmers that information leads them to believe that the bidding environment is more competitive than is actually the case. Faced with unrecoverable transaction costs, many farmers that could potentially offer attractive bids, simply choose not to bid. Likewise, some farmers with low quality-for-cost, believing things to be less competitive than they really are, make the opposite decision and enter a bid.

Once feedback on the VFM of successful bids is revealed after the first year's auction, some high quality-for-cost farmers that previously may have chosen not to participate are encouraged to enter a bid. Accordingly, after the first year we observe increasing numbers of high quality-for-cost farmers offering reasonable VFM bids. While the payment being asked for by farmers at a certain cost level may be increasing from year to year - explaining the bidding pattern in Figure 4 - the number of good VFM bids is also increasing as more farmers with high quality-for-cost participate in the auction - explaining the increased levels of cost-efficiency in the second year's auction that is documented in Table 4. In addition, once information from the first year's auction is released some low quality-for-cost farmers realise it is not actually worth their while bidding. The combination of high quality-for-cost farmers entering the auction and low quality-for-cost farmers choosing not to enter bids that incur them pointless transaction costs, leads to the progressive improvements in social efficiency.

The interaction of transaction costs and information feedback is one of the most important insights generated by the simulation analyses. It appears that **feedback can be a very important factor in improving both the cost efficiency and the social efficiency of a repeated auction scheme.**

Experimental Analyses

We turn now to consider complementary evidence from laboratory experiments designed to explore differences in bidding behaviour under different formats of information feedback between auctions. Table 5 records outcomes from a series of such experimental auctions. In those auctions subjects faced a transaction cost from bidding that was set at a magnitude comparable to that in the simulation. The

left hand columns summarise auctions where subjects were provided with VFM feedback on winning bids while the right hand columns summarise auctions where only limited feedback was provided.

Table 5: Performance Measures for Budget-Constrained Auction with Full Information and Restricted Information Feedback

| Year of Scheme | Full Information Feedback (n=190) | | | | Limited Information Feedback (n=254) | | | |
|----------------|-----------------------------------|--------------------|------------------------|--------------------------|--------------------------------------|--------------------|------------------------|--------------------------|
| | Marginal VFM ¹ | Part. ² | Cost Eff. ³ | Social Eff. ⁴ | Marginal VFM ¹ | Part. ² | Cost Eff. ³ | Social Eff. ⁴ |
| One | 9.00 | 84.2% | 14.46 | 16.37 | 9.73 | 84.3% | 14.03 | 16.10 |
| Two | 12.35 | 74.2% | 14.34 | 16.22 | 11.00 | 81.9% | 13.94 | 16.16 |
| Three | 13.04 | 64.7% | 14.37 | 16.80 | 11.56 | 74.4% | 13.84 | 16.23 |
| Four | 12.44 | 54.2% | 14.27 | 16.84 | 11.64 | 71.7% | 13.64 | 16.31 |
| Five | 12.83 | 52.6% | 14.23 | 16.78 | 11.64 | 65.7% | 13.60 | 16.16 |
| Average | 11.93 | 66.0% | 14.34 | 16.60 | 11.11 | 75.6% | 13.81 | 16.19 |

Notes: ¹ VFM of the lowest VFM bid accepted for funding; ² Percentage of farmers entering a bid; ³ Cost efficiency calculated as quality points per £ spent in the auction; ⁴ Social efficiency calculated as quality points per £ spent by farmers in foregone income and transaction costs

The rows of Table 5 record outcomes from the five years of successive auctions with averages displayed in the row labelled 'Overall'. Four different measures are recorded for each auction. The first column documents the marginal VFM; that is to say, the VFM offered by the worst bid accepted for funding. The second column details the proportion of subjects choosing to enter a bid in the auction. The third column provides our core measure of performance of the auction, cost efficiency. Finally the last column records social efficiency; that is to say, the real costs incurred per unit of environmental quality achieved.

Concentrate first on the left hand columns of Table 5 which report data from full information feedback treatments. The first pattern to note from Table 5 is that participation starts reasonably high with 84% of subjects entering bids in the first year but falls over successive rounds of the auction.

At first glance, that pattern of declining participation looks somewhat different to that which was observed in the simulation data. Accordingly, Figure 5 provides a summary plot of the experimental data providing a more detailed picture of the patterns of bidding behaviour.

Figure 5 conveys a lot of information. It plots the average bid by farms of each type for each year. Moreover the size of the points represents the proportion of bidders of that type entering a bid. Recall that farms of each type hold very similar costs and quality scores and that there are equal numbers of farms of each type in each auction. The grey ribbon depicts the range of VFMs accepted for funding through each year of the auction such that its bottom boundary traces out the path of the marginal VFM. The dark line depicts the path of the average bid.

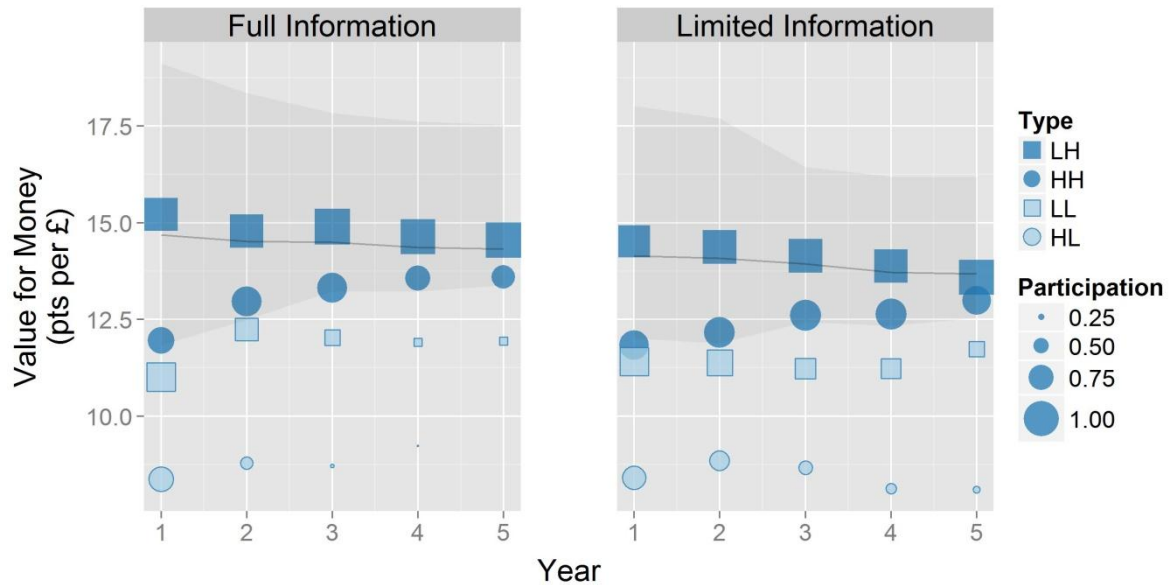


Figure 5: Bidding patterns in experimental auctions with full and limited information feedback

Concentrate first on the left hand panel of Figure 5 which depicts the same data on auctions with full information feedback as recorded in the left hand columns of Table 5. Notice that the size of the solid squares remains large across each auction, indicating on-going high participation amongst the most competitive (LH) farm type; a pattern identical to that seen in the simulations. In contrast, while participation remains strong amongst the moderately competitive (HH) farm type, with the experimental data we do not see the same significant increase in participation over successive years as was evident in the simulation data. We attribute that to differences in the cost distribution and competitive pressures in the experiments where in most circumstances only half of the moderately competitive group might expect to be funded.

Also notice that participation in the first year is high amongst the least competitive farm types (LL and HL) since subjects have very little idea as to whether they are able to offer competitive bids. But the optimistic participation seen in the first year soon dwindles as subjects learn from their own experience along with the feedback provided on winning bids that they are unlikely to win a contract through the auction. As can be seen in Table 5, the fact that uncompetitive subjects drop out as the auction progresses contributes to a general increase in social efficiency as those subjects avoid the unnecessary expense incurred through paying the participation cost.

The lack of increasing participation amongst farms in the competitive fringe explains why the experimental data in Table 5 shows declining cost from the first to the second year in contrast to the reverse observed in the simulation (Table 6).

On the other hand, closer analysis of Figure 5 confirms many of the conclusions we drew from the simulation data regarding patterns of bidding. Observe that over successive auctions the average VFM of highly competitive (LH) farm types progressively falls. We assume that feedback on the VFMs of winning bids reveals to this group that they have a competitive advantage and so encourages them to enter higher bids.

In contrast, we observe a marked increase in the average VFM offered by the moderately competitive (HH) farm types. Full information feedback provides clear signals to this group as to the VFM of the marginal bid, increasing competition between subjects at that margin and forcing that competitive fringe to enter progressively better VFM bids. In Table 5 that effect is witnessed by the rising marginal VFM over progressive year's auctions.

Accordingly, our analysis identifies four key effects on bidding behaviour generated by providing feedback between years of the auction;

1. Information alerts high quality-for-cost, competitive types to the possibility of shading up their bids, an effect which progressively pushes down cost efficiency.
2. Information generates clear signals as to the VFM of the marginal bid increasing pressures between those at the competitive fringe to reduce bids, an effect that progressively pushes up cost efficiency
3. Information encourages participation amongst competitive types who subsequently enter the auction offering good VFM bids, an effect which enhances cost efficiency
4. Information discourages participation amongst low quality-for-cost, uncompetitive types who then choose not to participate in the auction, an effect which increases the social efficiency of the auction.

Finally, consider the data in the right hand columns of Table 5 and its detailed depiction in the right hand panel of Figure 5. That data concerns a series of experimental auctions in which only limited information is fed back between years of the auction. The first key difference to note is higher levels of on-going participation in the auction, particularly amongst non-competitive farm types. When information is limited, uncompetitive farmers take longer to establish that they have little chance of bidding successfully in the auction. Limiting information feedback tends to reduce social efficiency.

Also evident in the data is the large cost efficiency advantage enjoyed by the full information treatment over treatments that somehow limit the feedback of information to farmers. A clue as to where that advantage arises can be found in comparing the data on the VFM offered by the marginal bidder. Despite starting off lower in limited feedback treatments, the marginal VFM rises more quickly and to a higher level in auctions where subjects receive full information feedback.

The data suggest that full information feedback provides bidders in the competitive fringe with exact details as to the level of VFM they have to target in order to have any chance of success in the auction. Competition amongst this group is enhanced by that information and results in a significant reduction in the level of bids posted in the auction.

Conclusion

In terms of recommendations concerning the design of a budget-constrained auction, **the simulation and experimental evidence points towards the fact that information increases competition and improves cost efficiency of the auction. Our analyses provide little support for forms of feedback that limit farmers' strategic opportunities for bid-shading.**

2.4.2 Guide Price

One way the government might influence bidding in an auction is by suggesting a guide price. A guide price is an amount that the auctioneer, in this case the government, quotes in advance of the auction as being the level of bid that they expect will be successful.

Suggesting a low guide price might encourage competitive bidding while publicising a generous guide price might encourage participation. We saw, for example, that in the first year's auction before farmers receive any feedback, some high quality-for-cost farmers are deterred from bidding because of the existence of transaction costs. Providing such individuals with a signal that they are competitive could potentially enhance the efficiency of the auction.

To explore the impact of guide prices, we simulated an auction with £20 transaction costs and VFM feedback and a variety of guide prices spanning the level of the marginal bid seen in previous

simulations; those consisted of a low guide price at £400, a medium guide price at £600 and a high guide price at £800. Comparison of bidding behaviour in those three simulated auction schemes is shown in Figure 6.

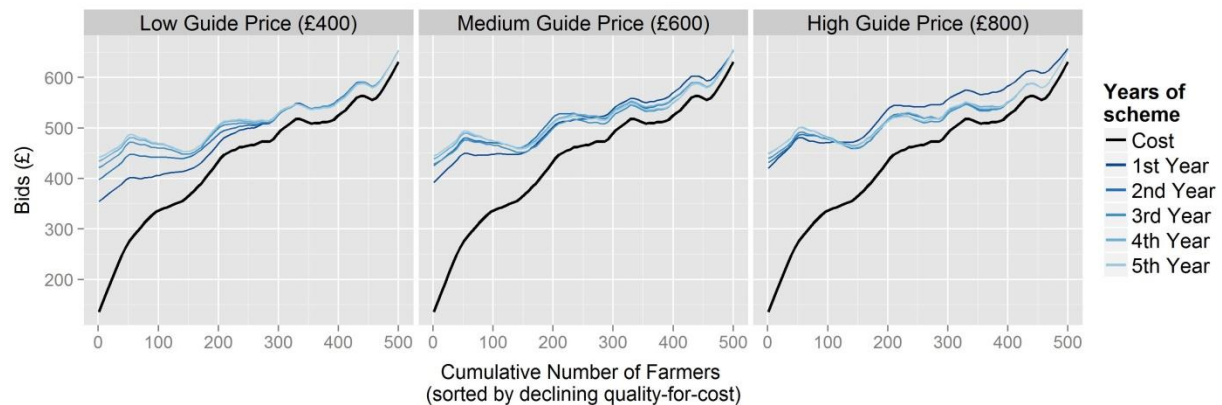


Figure 6: Bidding behaviour under different guide prices

The introduction of guide prices has a number of interacting effects. As one might expect, Figure 6 shows that in the initial run of the auction (the dark blue line) relatively low guide prices tend to pull down bids while relatively high guide prices encourage higher bids. That bidding pattern would suggest that in the first year's auction we might expect to see lower cost-efficiency as the guide price increases. At the same time, the participation data in Figure 7 shows a counteracting force: as the guide price increases more and more relatively competitive farmers are encouraged to bid in the first year's auction.

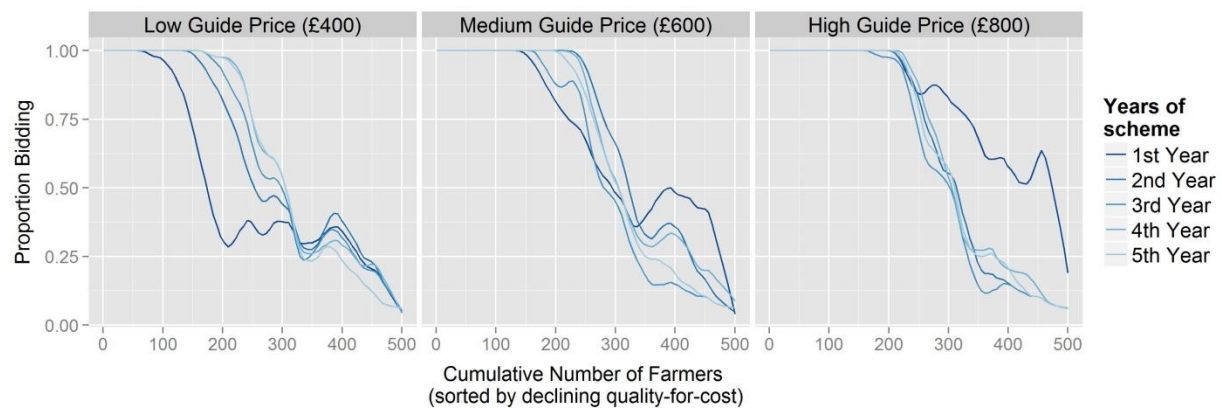


Figure 7: Participation under different guide prices

The data in Table 6 provides insights as to how those two counteracting effects play out in the aggregate. With the low guide price (£400), the fact that bids are relatively competitive is swamped by the lack of participation of competitive bidders; cost-efficiency in the first year is only 0.219 pts/£. With the medium guide price (£600), increased rates of participation from competitive bidders offsets generally higher payment requests leading to a cost efficiency in the first year of 0.238 pts/£. Increasing the guide price to £800, greatly increases participation, but that gain is counterbalanced by less competitive bidding such that cost efficiency in the first year remains at 0.238 pts/£. Referring back to Table 4, it is apparent that providing a medium or high guide price offers some minor gains in the first year over a scheme with no guide prices where cost efficiency is 0.235 pts/£.

Table 6: Simulated auction outcomes under different guide prices

| Year of Scheme | Guide Price | | | | | | | | |
|----------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|--------------------------|
| | £400 | | | £600 | | | £800 | | |
| | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ |
| One | 34.8% | 0.219 | 0.255 | 45.3% | 0.238 | 0.289 | 56.7% | 0.238 | 0.289 |
| Two | 40.2% | 0.238 | 0.287 | 43.8% | 0.240 | 0.299 | 40.9% | 0.238 | 0.302 |
| Three | 41.2% | 0.238 | 0.295 | 39.1% | 0.239 | 0.296 | 39.5% | 0.237 | 0.301 |
| Four | 41.8% | 0.239 | 0.298 | 43.1% | 0.239 | 0.300 | 41.7% | 0.236 | 0.302 |
| Five | 40.9% | 0.239 | 0.300 | 41.1% | 0.238 | 0.302 | 41.1% | 0.237 | 0.303 |

Notes: ¹ Participation rate in percent; ² Cost efficiency calculated as quality points per £ of govt. expenditure on contracts; ³ Social efficiency calculated as quality points per £ of farmer costs through taking on a contract

Unsurprisingly, feedback on actual winning bids erodes the guide price effect. Over successive auctions bids escalate in the low guide price auction but tend to fall in the high guide price auction. In contrast, participation rates increase in the low guide price auction, but fall in the high guide price auction. Indeed, the data in Table 6 suggests that over successive years, bidding patterns tend to converge. Conspicuously, cost-efficiency in the second and subsequent year’s auctions is somewhat lower than in the auction with no guide price (see Table 4). It appears that **the advantages that an appropriately positioned guide price may offer by way of encouraging participation in the first year may be eroded in subsequent years as a result of encouraging less competitive bidding.**

Experimental Analyses

Experiments were also carried out to explore the impact of guide prices on bidding behaviour. Treatments were run with two different guide prices. The low guide price was set halfway between the costs of the low-cost and high-cost farm types, sending a signal to the high cost types that they were unlikely to be successful in the auction. The high guide price was set at a level above the cost of the high cost farm types, sending a signal to every farmer that they might be successful. Bidding behaviour in those auctions is contrasted with an auction with no guide price in Figure 8 and summary details of those auctions transcribed in Table 7.

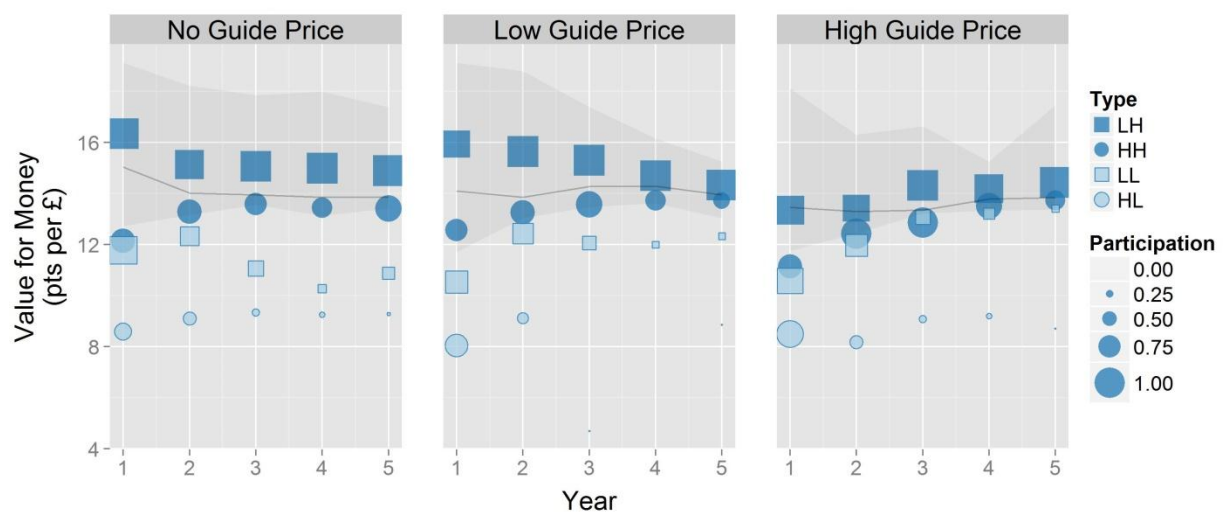


Figure 8: Bidding patterns in experimental auctions with different guide prices

Table 7: Experimental auction outcomes under different guide prices

| Year of Scheme | Guide Price | | | | | | | | |
|----------------|-------------------|------------------------|------------------------|-------------------|------------------------|------------------------|-------------------|------------------------|------------------------|
| | None (n=64) | | | Low (n=64) | | | High (n=62) | | |
| | Part ¹ | Marg. VFM ² | Cost Eff. ³ | Part ¹ | Marg. VFM ² | Cost Eff. ³ | Part ¹ | Marg. VFM ² | Cost Eff. ³ |
| One | 84.4% | 12.57 | 15.13 | 79.7% | 9.00 | 14.56 | 88.7% | 11.20 | 13.72 |
| Two | 71.9% | 13.04 | 14.65 | 73.4% | 12.95 | 14.68 | 77.4% | 12.35 | 13.68 |
| Three | 64.1% | 13.52 | 14.53 | 60.9% | 13.38 | 14.63 | 69.4% | 13.04 | 13.95 |
| Four | 54.7% | 12.80 | 14.52 | 48.4% | 12.44 | 14.35 | 59.7% | 13.26 | 13.95 |
| Five | 60.9% | 13.38 | 14.41 | 46.9% | 12.83 | 14.12 | 50.0% | 13.33 | 14.14 |

Notes: ¹ Proportion of farmers entering a bid; ² VFM of the lowest VFM bid accepted for funding; ³ Cost efficiency calculated as quality points per £ spent in the auction

As with the simulation data, the high guide price encourages participation in the first year's auction. Some 89% of those seeing the high guide price register a bid compared to only 80% of those seeing the low guide price. Once again, however, due to the nature of the cost distribution in the experiment that participation effect is most pronounced for the non-competitive (HL) farm types and not for farmers in the competitive fringe. Accordingly, the participation effect does little to enhance cost efficiency in the high guide price treatment. Rather, we observe that the high guide price leads to significantly inflated bids in the first year; notice in Figure 8 the difference in the average VFM bid by highly competitive (LH) farm types in the first year. As a result, and as detailed in Table 7, the high guide price treatment returns significantly lower cost efficiency in the first year.

Over subsequent years' auctions, bidding patterns tend to converge. Noticeably in Table 7 we witness increasingly high VFM bids from the highly competitive (LH) farm types in contrast to declining VFM bids from the same farm types in the low guide price auction.

Conclusion

Our analysis demonstrates that guide prices have the ability to shape bidding behaviour particularly in the first year's auction before farmers begin to receive feedback on real bids. The impact of guide prices consists of two opposing effects: a high (low) guide price tends to encourage (discourage) participation while inflating (deflating) bids from those that participate. While the relative size of those effects will be dependent on the particular circumstances of the auction, it appears that the best strategy for setting a guide price is to fix it around a truthful estimate of the likely marginal bid. Such a guide price will encourage participation from those farmers who are on the competitive fringe while discouraging participation from non-competitive farmers. Likewise, a guide price set at that level will give relatively little encouragement to highly competitive farmers to shade up their bids.

In both the simulation and experimental work, we find little evidence to support the idea that guide prices can be used to improve the cost efficiency of the auction. While some small gains may be made in the first year, those are offset by changes in cost efficiency in subsequent year's auctions. Perhaps the single most convincing argument for a guide price is that, by reducing the perceived risk of bidding, it can be used to encourage participation in the first year's auction, a factor that may be important in enhancing engagement in a real world application.

2.4.3 Comparison to Fixed Price Alternatives

A central objective of the simulation environment is to provide a means of comparing auction outcomes with those of alternative fixed-price allocation mechanisms. Figure 9 provides a graphical representation of such a comparison for a scheme where farmers incur £20 transaction costs.

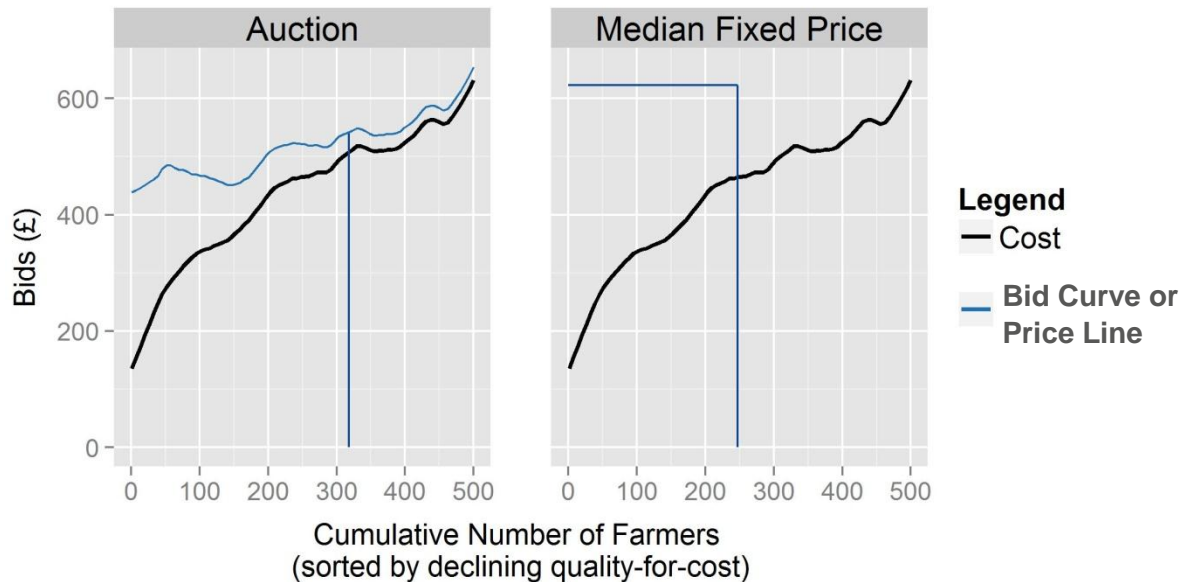


Figure 9: Comparison of pricing and quantity outcomes for schemes using different allocation mechanisms when transaction costs are £20

The left-hand panel records the auction outcome in the fifth year where the vertical line represents the number of farmers funded through that auction, in this case 318. Approximately speaking the budget can be visualised as the area under the bid curve up to that vertical line. The right-hand panel shows the outcome for a fixed price alternative scheme in which the government fixes the price at what it believes to be the median cost of farmers. In this case the price is £622.48 and a total of 247 contracts are awarded each receiving that price as a payment. Again, the budget can be visualised as the area below the price line up to the vertical line at 247 farmers.

The clear message is that the auction mechanism outperforms this fixed-price alternative scheme. Notice, that the bids received in the auction are lower than the price that farmers would have received under the median fixed price scheme. The savings the government makes through the auction, therefore, allows for more farmers to be funded through the scheme budget. Indeed in the simulation, 71 more farmers or roughly 30% more contracts are awarded. Overall, therefore, the auction proves to be significantly more cost-efficient than the median fixed price scheme. In the 5th year of the scheme the auction is approximately 15% more efficient returning 0.240 units of environmental quality for every pound spent as compared to 0.205 pts/£ through the median price scheme.

The specific outcomes of the two schemes over all 5 years of simulations are compared in Table 8. Notice that as with the auction, farmer bidding behaviour in the median price scheme changes from year to year. In the first year, participation in that scheme is 53.1% but this creeps up to 57.7% as feedback on the VFM of winning bids is revealed after successive auctions. Some minor gains in cost efficiency are precipitated as the auctions progress, but the fixed price scheme never manages to achieve the levels of cost efficiency observed in the auction.

Table 8: Auction outcomes compared to those from alternative fixed price schemes

| Transaction Costs of £20 and VFM Feedback | | | | | | | | | |
|---|-------------------|------------------------|--------------------------|---|------------------------|--------------------------|---|------------------------|--------------------------|
| Year of Scheme | Auction | | | Median Fixed Price (full transaction costs) | | | Median Fixed Price (half transaction costs) | | |
| | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ | Part ¹ | Cost Eff. ² | Social Eff. ³ |
| One | 40.1% | 0.235 | 0.278 | 53.1% | 0.204 | 0.267 | 58.0% | 0.205 | 0.282 |
| Two | 44.5% | 0.243 | 0.297 | 54.6% | 0.205 | 0.270 | 58.5% | 0.205 | 0.281 |
| Three | 40.5% | 0.242 | 0.297 | 56.1% | 0.205 | 0.271 | 59.2% | 0.205 | 0.283 |
| Four | 42.0% | 0.240 | 0.299 | 56.9% | 0.205 | 0.272 | 60.2% | 0.206 | 0.286 |
| Five | 41.0% | 0.240 | 0.300 | 57.7% | 0.205 | 0.272 | 60.4% | 0.206 | 0.286 |

Notes: ¹ Participation rate in percent; ² Cost efficiency calculated as quality points per £ of govt. expenditure on contracts; ³ Social efficiency calculated as quality points per £ of farmer costs through taking on a contract

Notice also from Table 8, that the social efficiency of the auction is always superior to that of the median price scheme. That result follows from the fact that the fixed price scheme is unable to award contracts to those with costs above the fixed price even if those farmers can also offer excellent environmental quality.

Finally, in the last three columns of Table 8 we consider a scenario in which the transaction costs of participating in the auction exceed those of non-auction alternatives. In particular, we imagine a situation in which participation in the fixed price scheme imposes half the transaction cost on farmers as participation in the auction. Naturally, with lower transaction costs the cost efficiency and social efficiency of the fixed price scheme increase, but observe that the auction continues to perform better in terms of cost-efficiency across each of the five years of the scheme.

Conclusion

The simulation environment provides a strong endorsement for employing an auction mechanism for the allocation of agri-environment contracts. In all cases, **our simulations based on cost data from the Farm Business Survey suggest that an auction outperforms the most likely alternative mechanism; a scheme offering a fixed price set at around the central cost.** Of course, there is no guarantee that the distribution of costs used in this analysis will reflect the distribution of costs amongst farmers bidding in some particular agri-environment auction. The relative efficiency of the auction compared to a fixed price alternative depends on the cost distribution, an issue we turn to address in the next section.

2.4.4 The Crucial Role of Cost-Distribution Assumptions

In this section, we wish to sound a note of caution by stressing that this conclusion is very much dependent on our assumptions regarding the distribution of costs (and quality) being reasonable reflections of reality. To understand how things might differ under alternative assumptions consider the analyses graphed in Figure 10 which depict the outcomes of different mechanism under three alternative simulations of cost distributions.

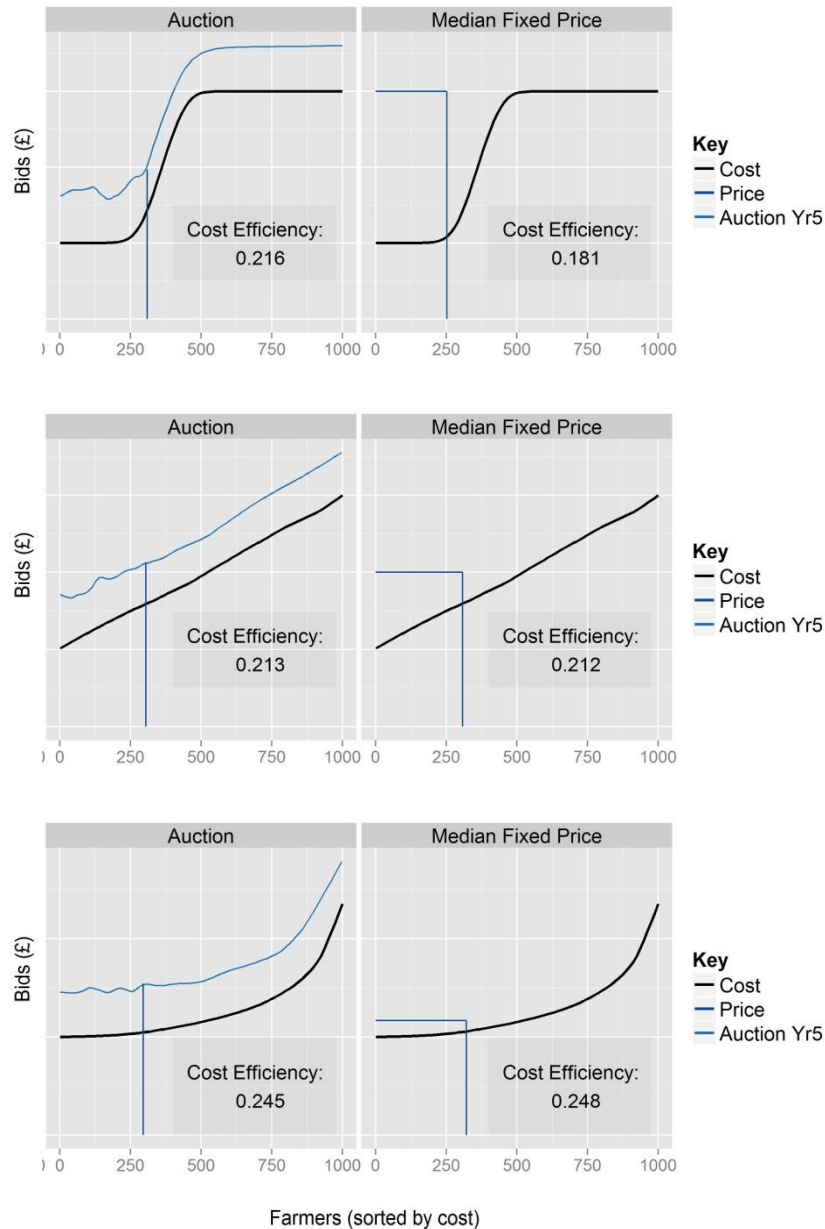


Figure 10: Comparison of pricing and quantity outcomes for three different simulated cost distributions with transaction costs of £20

Figure 10 depicts the outcomes of different mechanisms under three alternative simulations of cost distributions. The top row describes outcomes for a simulated cost distribution defined on the range between £400 and £600. In this distribution there are a large number of farmers with the lowest cost and even more with the highest cost, and the cost distribution rises steeply over the range where the marginal contract is likely to be found. Since more than 50% of farms have the top cost, the median price takes on this upper boundary and performs particularly poorly returning a cost-efficiency of just 0.181. Not surprisingly, the cost-efficiency of the auction is significantly larger at 0.216 and, as with the FBS data, we find the auction also out-performs the optimal fixed price scheme.

The middle row of Figure 10 plots outcomes for a simulation in which farm costs are distributed uniformly across the same range from £400 to £600. With this cost distribution we see a very different outcome with almost identical cost-efficiency being achieved by the two mechanisms.

Finally, the cost distribution underpinning the graphs in the bottom row of Figure 10 has a large number of low-cost farms with just a small group of relatively higher-cost providers. In this case, we find that the auction performs the worst of the two mechanisms.

We reiterate the clear warning that **the value of the insights provided by the analyses reported in previous sections is highly dependent on the realism of the assumptions made regarding the distribution of costs and quality.**

2.5 All or Nothing and Pick and Mix Auction Formats

An extension to the auction format described above introduces the complexity of allowing for two different activities in the agri-environment scheme. Our particular interest is in situations where the government would like to encourage farmers to undertake both activities on their farm since the combination of activities delivers additional environmental benefits. In order to encourage the uptake of both activities (and following the advice of the project steering group) we consider a scheme in which the government confers a bonus of 25pts on to the quality score of a farmer bidding for both activities. Clearly the bonus increases the VFM of such bids and hence increases a farmer's chance of being successful in the auction.

As a simple illustration, consider the case where each farmer has two fields. Under agricultural production, the fields generate different incomes; if a field is entered into an agri-environment scheme the income from this field is foregone. Under our hypothetical agri-environment scheme, each farmer's first field is only eligible for activity A, while their second field is only eligible for activity B. For simplicity, we assume that for one farmer the environmental benefit conveyed by activities A and B is the same, but that that benefit differs across farmers. That simplification, permits differences in potential value for money across the two fields but allows us to focus on the role of differences in foregone income; as such, the extension to heterogeneous qualities is trivial.

Our analysis explores the question of how to elicit bids for multiple items in an auction. In particular, we focus on two potential elicitation formats which we refer to as (i) an All or Nothing format and (ii) a Pick and Mix format.

In an All-or-Nothing format, farmers enter a single bid, which describes whether they are offering to do one, the other, or both activities. The All or Nothing format forces bidders to choose between one of three potential bid options: bid for activity A; bid for activity B; or bid for activities A and B together. Of course, a bid for activities A and B together prompts the award of the 25pt quality bonus, a fact that may encourage uptake of that option.

In contrast, the Pick and Mix format allows farmers to provide a bid for activity A and a bid for activity B, and forces the bid for both to equal the sum of those two bids. The government decides whether to accept one, both or none of those bids on the basis of VFM. Again the value of a farmer undertaking both activities is reflected in the VFM of that combined option being evaluated after the addition of 25pt quality bonus. The Pick and Mix format removes some of the risk to farmers, enabling them to bid on both options independently and allowing the government to select bids in such a way as to reap the benefits of potential quality bonuses.

Since foregone incomes differ across farmers' fields, their quality-for-cost for each activity is also likely to differ. Their decision as to how to bid is shaped by the trade-off between asking for a lower payment in order to increase the probability of winning and asking for a higher payment so as to increase the size of payment if that bid is successful. With the All or Nothing format farmers evaluate this trade-off for all three possible combinations of bid (i.e. A only, B only, or A and B together) electing to put forward that particular bid which maximises their expected profit. With a Pick and Mix format a farmer's task is

reduced to determining the value of their bid for A and the value of their bid for B, taking into account the range of possible winning outcomes.

Despite the quality bonus, in an 'All or Nothing' auction, competition and risk aversion act to push farmers towards bidding for their highest VFM option rather than to bid for both options together. This behaviour is clearly identified in Figure 11, where we plot data from a simulation that summarises how bidding choice amongst our simulated farmers differs according to how their quality-for-cost for activity A compares to that from activity B. In this example, foregone agricultural income from the two fields in which the different activities are undertaken is uncorrelated. The three curves in Figure 11 plot the proportion of farmers deciding to submit a bid for A and B (solid line), only A (dashed line) and only B (dot-dash line) at each level of difference between the quality-for-costs of the two activities undertaken in the different fields. So farmers to the left of the graph can offer much higher quality-for-cost for activity B than for activity A, while for those to the right of the graph the opposite is true.

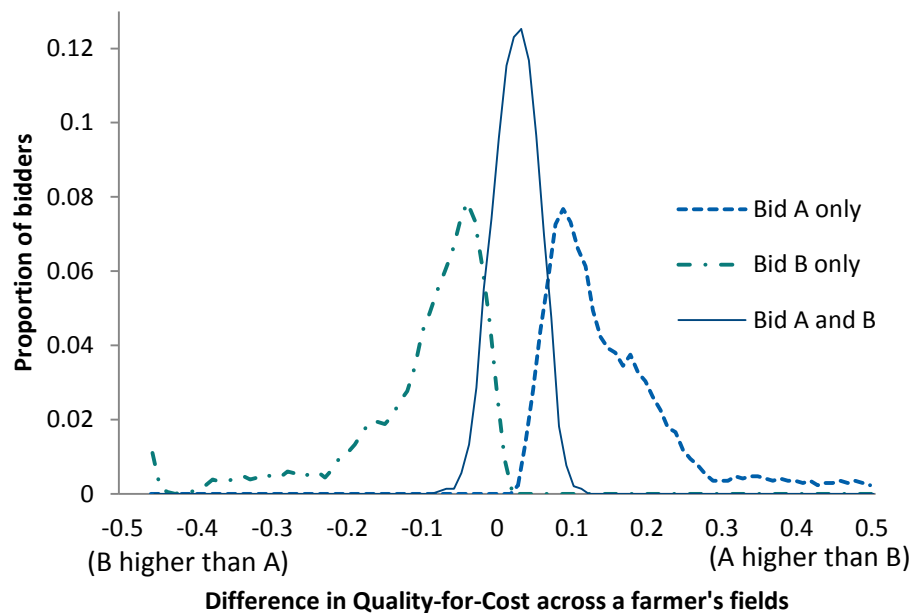


Figure 11: How the proportion of farmers choosing different combinations of bid relates to the size of the difference in quality-for-cost for activity A and Activity B. The opportunity costs of the activities are uncorrelated

Observe that in an All or Nothing auction format, farmers who can offer a better bid for activity B tend to offer only B, concerned that adding activity A to their bid will reduce their competitiveness in the auction. Likewise those who can offer a relatively good bid for activity A, tend to choose the safer option of just bidding for A. Only when the quality-for-cost for the two activities is very similar does the 25pt bonus provide sufficient incentive for farmers to risk bidding for both activities.

Table 9 presents details from a series of simulations of the All or Nothing format auction and compares those to simulations with identical set ups run with a Pick and Mix format auction. With the Pick and Mix format, of course, there is no risk associated with bidding for both activities since bids for the two activities are entered and evaluated separately. We observe, that the Pick and Mix format is reliably more cost efficient than the All or Nothing format. Interestingly, the two auction formats perform similarly in terms of social efficiency; this indicates that the difference in format has little impact on the identities of winning farmers but instead affects cost efficiency through its influence on bid shading.

Table 9: Performance of Pick and Mix, All or Nothing auction formats

| Auction format | Multiple Agri-environmental Activities (bonus = 25) | | | | | |
|----------------|---|-------------|--------------------------------|-------------|--|-------------|
| | Negatively correlated foregone incomes | | Un-correlated foregone incomes | | Positively correlated foregone incomes | |
| | Cost Eff. ³ | Social Eff. | Cost Eff. ³ | Social Eff. | Cost Eff. ³ | Social Eff. |
| All or Nothing | 0.257 | 0.313 | 0.278 | 0.333 | 0.296 | 0.337 |
| Pick and Mix | 0.283 | 0.324 | 0.312 | 0.329 | 0.331 | 0.339 |

It is notable that both mechanisms perform less efficiently when the opportunity cost of activities A and B are negatively correlated, such that a low opportunity cost of undertaking one activity is, on average, associated with a high cost of undertaking the other, causing the difference in potential VFMs to be larger. This large difference in potential VFM leads to specialisation in either A or B, therefore removing the benefits of the quality bonus and reducing efficiency.

In conclusion, we find that a **Pick and Mix auction format provides greater efficiency than an All or Nothing format by removing an element of risk for bidders and allowing them to offer a broader menu of bids from which the government can choose.**

2.6 Target-Constrained Auctions

Our second major set of analyses concern target-constrained auctions. While the simulation environment was developed to allow for analysis of target-constrained auctions, the time constraints of this project mean that here we are only able to present findings from our experimental investigations.

The target-constrained auctions are designed to emulate situations in which the objective is to deliver specific environmental targets within some particular landscape. In this case, there is no repetition of auctions over the 5 year time frame. Instead, in the first year subjects compete in a one-off auction for 5 year contracts. If a target number of eligible bids are received in that auction then those bids offering the best VFM are selected for funding. If the target is not achieved then the auction was deemed a failure and no contracts were funded. As with all the other experimental auctions, a small participation cost was associated with entering a bid in the auction.

2.6.1 Target Auction: Small Targets

Table 10 summarises the outcomes of a series of auctions which sought to reach the reasonably modest target of funding 6 out of the 16. Results from three designs are reported. First a one-shot auction where the target is met at the first attempt or the auction fails and is not rerun. Second, a 'Two-Period' auction format. Once the first period closes, subjects are provided with full information feedback on the bids that currently occupy the winning places. The auction then opens for further bids or revision of bids before closing for good at the end of the second period. Finally, we explore a 'Follow-Up' auction format in which a second auction is run if and only if the first auction fails to garner enough eligible bids to reach the target.

Observe from *Table 10* that in all cases subjects were able to reach the relatively small target, though in one case the follow-up auction was called into play in order to achieve that goal. Notice also the significant difference in rates of participation across the different formats. In particular, participation in the one-shot target auction is appreciably lower than in the other formats; while participation is somewhat greater in the follow-up auction and greater still in the two-period auction. That ordering of participation rates reflects the differences in risk that subjects face when weighing-up the merits of bidding in the auction and paying the participation cost, only to discover that the auction has failed

because too few other farmers have entered bids to reach the target. In the follow-up auction format farmers know that the auction will be rerun in the event of such a failure and in the two-period auction, the auction cannot fail until the second period has completed.

Table 10: Performance Measures for Target-Constrained Auctions with a Small Target

| Measure | One-Shot | Two-Period | | Follow-Up | |
|-------------------|----------|------------|-------|-----------|-----------|
| | | Prd 1 | Prd 2 | Initial | Follow-Up |
| Success | 100% | 100% | 100% | 83% | 100% |
| Participation | 61% | 81% | 90% | 68% | 70% |
| Social Efficiency | 15.44 | 13.76 | 14.03 | 14.98 | 15.03 |
| Cost Efficiency | 14.36 | 12.52 | 13.37 | 13.97 | 14.07 |

Those differences in risk seem to also guide bidding behaviour. Observe that bidding in the one-shot auction is the most competitive, resulting in the highest level of cost-efficiency amongst the small-target auctions (14.36 pts/£). The follow-up format where at each stage of the auction there remains a chance of being out-competed, records marginally worse cost efficiency (14.07 pts/£). Finally, the two-period format records the lowest cost-efficiency (13.37 pts/£). Here bids in the initial period carry very little risk since they can always be revised in the second period. Accordingly, those first round bids are the most speculatively exaggerated (cost efficiency; 12.52 pts/£).

For small targets, therefore, a one-shot auction dominates other possible designs though the Follow-Up auction format provides reasonably comparable performance.

2.6.2 One-Shot Target Auctions: Large Targets

Table 11 records the same performance statistics for a series of experimental auctions in which the intention is to distribute contracts to a large target of 12 out of 16 farmers. In this section we focus attention on three formats that each only afford one bidding opportunity. The first is a simple one-shot auction. The second is a target auction with an additional budget constraint. The final format is one in which subjects not only compete with each other but with neighbouring “regions” (for which read groups of 8 subjects) to secure funding.

Table 11: Performance Measures for One-Shot Target-Constrained Auctions with a Large Target

| Measure | One-Shot | Budget Constraint | Regional Competition |
|-------------------|----------|-------------------|----------------------|
| Success | 50% | 25% | 75% |
| Participation | 74% | 67% | 66% |
| Social Efficiency | 13.46 | 11.41 | 13.38 |
| Cost Efficiency | 12.38 | 12.11 | 13.03 |

A potential issue with auctions seeking to issue a large number of contracts is that the existence of a large target releases competitive pressures that keep a cap on bids. The auction formats explored in this section were designed with the intention of introducing alternative sources of competitive pressure in order to avoid that eventuality. However, the first row of Table 11 makes for uncomfortable reading. We find that half of the time, these large target auctions fail due to an insufficient number of subjects

submitting bids. Clearly for many subjects the added competitive pressures in these formats designed to avoid excessive bidding simply encourages non-participation.

2.6.3 Two-Shot Target Auction: Large Targets

While one-shot auction mechanisms proved to perform poorly in trying to achieve a large target, two-shot mechanisms perform considerably better. Consider the summary details documented in Table 12. Here we see that in both the first period of a two-period auction and in the initial run of a follow-up auction format we again fail regularly to reach the target. However, with both these formats, that failure is not the end of the auction. Information on the bids received in either the first period or the initial auction are made available to subjects who may use that information in considering how to bid in the subsequent auction. This subsequent auction successfully achieves the target on every occasion.

Comparing the Two-Period and the Follow-Up auction we observe (as we did in the small target case) that bids in the first period of the Two-Period format and the initial auction of the Follow-Up format exceed those received in the subsequent auction. We suspect that is because subjects bidding in that subsequent auction know that there will be no further opportunities to secure a contract; if they bid too high and do not get selected for funding. Notice also that bidding in the Follow-Up format is more competitive than in the Two-Period format; the former results in a cost-efficiency score of 11.47, the latter a score of 11.89.

Table 12: Performance Measures for One-Shot Target-Constrained Auctions with a Large Target

| Measure | One-Shot | Two-Period | | Follow-Up | |
|-------------------|----------|------------|-------|-----------|-----------|
| | | Prd 1 | Prd 2 | Initial | Follow-Up |
| Success | 50% | 50% | 100% | 67% | 100% |
| Participation | 74% | 80% | 91% | 87% | 91% |
| Social Efficiency | 13.46 | 14.03 | 14.38 | 14.47 | 14.50 |
| Cost Efficiency | 12.38 | 11.76 | 11.47 | 12.19 | 11.89 |

Again we speculate that that performance advantage arises from the relatively higher risks associated with bidding in the Follow-Up format. Even in the first auction of that format, subjects must enter a bid that they believe has a reasonable chance of being selected; if they bid too high then the target may be reached through the bids of other farmers and the format will not progress to the follow-up auction.

As a result, the experimental data points to the conclusion that **where relatively large targets are sought, a two-shot auction possibly formulated in the Follow-Up format will tend to dominate one-shot designs.** Moreover, the Follow-Up format tends to perform relatively well even when a small target is required making a strong case for adoption of the Follow-Up format for implementation of target auctions in Countryside Stewardship.

2.7 Conclusions

With the major caveat that the findings of the simulation analysis are dependent on the realism of the calibration of the simulator, particularly in defining the distribution of costs, we reach a number of clear conclusions.

First, we find that within our simulation an auction provides better cost-efficiency than an alternative scheme which offers a fixed price set around the centre of the cost distribution. We are careful to note



that this conclusion is very much dependent on our assumptions regarding the distribution of costs (and quality) being reasonable reflections of reality.

Second, we find that there are good reasons to support the provision of feedback on the VFM of winning bids between successive years of agri-environment auctions. While this information provides high quality-for-cost farmers with cause to shade up their bids, it also encourages participation from farmers that are capable of offering good VFM bids. That increased participation adds to increasing competition between farmers at the competitive margin encouraging that group to enter progressively better VFM bids. In our simulation, feeding back on VFM leads to higher cost efficiency and higher social efficiency than schemes that limit the information shared with farmers between auctions.

Third, in both our simulations and experiments we find evidence to suggest that auction outcomes can be manipulated by the publication of guide prices. That impact is not large and erodes over successive years of auctions as information on the VFM of actual winners is fed back to participants. The impact of guide prices tends to have contrasting participation and bidding effects. It appears that the primary benefit of a guide price is in increasing participation in the first year of the scheme. With regards to setting the level of a guide price a sensible strategy is to fix that price around a truthful estimate of the likely marginal bid. Such a guide price encourages participation from those farmers who are on the competitive fringe while discouraging participation from non-competitive farmers. Likewise, a guide price set at that level will give relatively little encouragement to highly competitive farmers to shade up their bids.

Fourth, in our simulations of budget-constrained auctions for two agri-environment activities we find evidence to suggest that a Pick and Mix auction format (where farmers submit one bid for activity A and one bid for activity B and could be successful in none, one or both bids) leads to greater efficiency than an All or Nothing format (where farmers are forced to submit a single bid for either activity A, activity B or both activities A and B). The efficiency gains of a Pick and Mix format are greater when the opportunity costs of activities A and B are positively correlated or uncorrelated and the efficiency gains are lower when the costs are negatively correlated.

Finally, in a landscape-scale target auction, the experimental evidence favours the use of a Follow-Up auction format. We find that such a format maintains sufficient competition to ensure bids are not inflated in the initial round while lowering the risks of participation by holding out the possibility of a follow-up auction if the target is not initially achieved. The Follow-Up format performs well in both the small target and large target setting, suggesting that it may be robust to a number of different target auction settings.

Overall, and with the now familiar caveat, our simulations and experiments suggest that an auction mechanism could offer efficiency advantages over a fixed price scheme. Those advantages are most pronounced when there is widespread participation in the scheme. Since transaction costs deter participation, the simulations suggest that reducing the transaction costs of participating in an auction is an important consideration. A second way to encourage participation is to reduce some of the uncertainty over the likelihood of success; an outcome that might be achieved through the provision of guide prices and publicising the VFMs of winning bidders. Clearly the challenge here is to release enough information to encourage participation without releasing so much information that high-bidding is encouraged amongst farmers that might otherwise offer high VFM.

3 Farmer workshops on reverse auctions

Two workshops were held with farmers in Yorkshire in summer 2014 to explore attitudes to the use of reverse auctions for allocation of funding under the new environmental land management scheme 'Countryside Stewardship', which will succeed Environmental Stewardship in England under RDPE 2014-2020. The aim was to test farmers' views on the concept of an auction process and explore responses through a bidding exercise across at least two farming contexts, in this case upland livestock farmers and lowland arable farmers. The participants were recruited around existing groups known to ADAS in the region on the basis that this would secure attendance and provide a familiar context for farmers to contribute openly and fully. Additional information is provided in annex 4.

As part of the process, it was necessary to introduce the move to Countryside Stewardship where access to funding for managing the environment will be based on targeting and spatial scoring. In hindsight, this proved a challenging concept for many farmers and meant that they found it difficult to separate it from the mechanism for allocation of funds, namely reverse auctions.

3.1 Farmer responses

Uplands workshop

This small focus group of 12 upland farmers found the concept of reverse actions for agri-environment schemes difficult to grasp and take part in but they provided valuable feedback for the study. In the context of the research study, the key issues raised by farmers were:

- Farmers' capacity to participate in an auction system, in terms of using the IT infrastructure effectively, was challenged.
- A 5-year auction-based system is at odds with securing long term environmental goals.
- A risk of 'trading down' in payment rates to secure an agreement.
- A risk of collusion at a local scale where individual agents acted on behalf of neighbouring farmers.
- Inability of small family farmers to compete on cost with non-farming land owners with economies of scale.

Arable workshop

This small focus group of 10 arable and mixed farmers were not enthusiastic about the concept of targeting Countryside Stewardship through environmental scoring. The issue of bidding under an auction system was an additional complication which they did not perceive as an opportunity to negotiate the new rules. However, they did take part in bidding rounds and have provided valuable feedback for the study.

In the context of the research study, the key issues raised are:

- Importance of setting the value for money threshold at an appropriate level.
- The ability to enhance scores by bundling options.
- In some instances farmers did not bid.
- Perverse incentive to bid low and cut costs of establishment and management of options.
- Loss of currently secure environmental outcomes when farmers fall out of agreements.
- Large scale farmers and contractors with economies of scale will be favoured over family farms.
- A more complex bidding process would increase reliance on agents or advisers.
- Issues of poor access to broadband might limit participation in an online auction process.

3.2 Implications for the use of reverse auctions

There are a number of common themes across the two workshops which need to be considered in a piloting phase, namely:

- i. The context for accessing agri-environment schemes. It will be important that the new competitive Countryside Stewardship scheme is in place ahead of any piloting of auctions so that the competitive element is not associated only with the auction mechanism.
- ii. The platform used for bidding should be easy to use and avoid the need to undertake complex calculations on value for money.
- iii. The environmental scoring element should be transparent and robust (able to withstand challenge) at a farm scale.
- iv. Information on previous successful bidding rounds, guide prices etc. should be made available (within the constraints of the design elements being tested) so that farmers can anchor their bids and to encourage participation from farmers that are capable of offering good VFM bids.
- v. The pilots should explore opportunities to allow farmers to combine options e.g. as bundles, to secure uptake of a coherent set of options at farm and landscape level, including more difficult options.
- vi. The pilots should explore opportunities to allow farmers to commit to longer timescales (> 5 years) to test the impact on participation and VFM.

4 Linking agri-environment and wider PES initiatives

Until recently, most finance available to farmers for ecosystem maintenance and enhancement has been made through publicly funded schemes. More recently, the private sector has come forward with initiatives to offer finance, in conjunction with public funds, for land managers to improve water quality (Upstream Thinking⁶ and Catchment Wise⁷) and to sequester carbon (Woodland Carbon Code⁸). In theory public and private finance could be brought together in different ways to encourage the desired changes to land management. For instance:

- private finance could be used to introduce new options to agri-environment schemes, or make existing options more financially attractive to farmers;
- projects could combine funding from a variety of funding sources e.g. from agri-environment schemes and from selling carbon credits through the new Peatland Carbon Code⁹.

There are potentially a number of advantages in designing a public environmental land management scheme that allows the inclusion of private funding (see section 4.1). However, for a jointly funded scheme both public and private sector criteria would need to be met; for the public agency this relates in particular to EU funding rules while for the private agent, funding may be much more flexible. Public schemes are also likely to cover a wide range of environmental objectives while those for a private agent may be very specific and limited.

In considering the potential models for integrating funding, the project team interviewed a number of private sector stakeholders that would potentially be interested in PES schemes to ascertain their readiness to participate (detailed at annex 5). Smith et al (2013) identify three types of potential buyers of ecosystem services¹⁰ – Primary, Secondary and Tertiary buyers – according to the point at which they benefit from use of the ecosystem services. For this analysis we have characterised the businesses interviewed under three discrete groups based on their use of the engagement with PES concepts:

1. **PES Ready:** the water companies are actively engaged in seeking improvements to ecosystem services (water quality) by working directly with land managers and interested third parties. The focus is very location specific.
2. **Investors in ecosystem services:** food producers and retailers have ongoing engagement with land managers. This is mostly productivity driven but there is interest in achieving more with their current investments for a broad set of objectives that include supply chain resilience as well as landscape scale impacts. The focus is local to international.
3. **PES Interested:** this category includes developers and the insurance industry who were less closely linked with land managers but have an interest in the principles of managing land to support their wider objectives. The focus is site specific.

⁶ A South West Water initiative started in 2008 to improve water quality through land management <http://upstreamthinking.org/>

⁷ A United Utilities initiative to tackle pollution at source to improve the quality across the North West <http://corporate.unitedutilities.com/catchmentwise.aspx>

⁸ Forestry Commission (2011) Co-funding of woodland creation through EWGS and carbon finance at: [www.forestry.gov.uk/pdf/ON020-EWGS&CarbonFinance.pdf/\\$file/ON020-EWGS&CarbonFinance.pdf](http://www.forestry.gov.uk/pdf/ON020-EWGS&CarbonFinance.pdf/$file/ON020-EWGS&CarbonFinance.pdf)

⁹ A pilot study for Defra on developing a Peatland Code suggests that joint funding of peatland restoration from both private funding and agri-environment schemes would be possible, but that further investigation is needed http://randd.defra.gov.uk/Document.aspx?Document=11566_DefraPESPilotPeatCodeFinalReport.pdf

¹⁰ Our health and wellbeing depends upon the services provided by ecosystems and their components: water, soil, nutrients and organisms. Therefore, ecosystem services are the processes by which the environment produces resources utilised by humans such as clean air, water, food and materials.

This chapter focusses principally on the PES Ready group, namely water companies. This is partly driven by the relatively advanced stage of their interest but also reflects their urgent need to build an evidence base on the effectiveness of land management activities in mitigating non-point sources of pollution that affect water quality. More details regarding the interviews can be found in annex 5.

In the following sections we consider:

- Some simple models that could bring together public and private funding for agri-environment schemes;
- The requirements of respective private and public funds for investment in agri-environment activities that would need to be addressed for a joint public-private scheme to work. These relate to both the concerns of the private stakeholders as well as the EU requirements for the public scheme;
- Consideration of the models against the requirements;
- Next steps.

4.1 Models for public/private funding of agri-environment schemes

Below we describe three elements of scheme design that are relevant when considering how public and private schemes could be linked. These are: independent or combined schemes; independent or brokered/co-ordinated purchasing; and the rules of purchasing.

Independent or combined schemes

Most simply, the combination of public and private funding of schemes under a single administration could result in administrative cost savings for all parties. A further advantage could arise from providing farmers and land managers with a single interface to agri-environment funding that minimises the transactional costs of making applications. More ambitiously, a joint private and public design opens up the possibility of coordinating the two streams of investment to bring efficiency benefits for both parties, achieving the same environmental benefits at a lower cost or greater benefits at the same cost.

Conceptually one can think of the two funding streams being combined or managed in parallel. A number of potential issues need to be considered, namely:

- Risk of competition in effort and issues of overlap or gaps in provision - at the very least an element of coordination is required.
- Opportunities for coherence and synergy between environmental objectives may be missed. For example, pursuit of one objective through private funding may be at the detriment of another for which there is only public funding.
- Separate schemes could be confusing for applicants.
- Private agents ready to consider joint schemes with the public authority typically have limited experience of operating schemes of this type.
- Options offered under the existing publicly funded scheme rely on implementation of management practices but outcomes are often difficult to measure; this may prove a limitation for private agents.
- The spatial scale for the existing publicly funded scheme may not coincide with the area of most interest to private agents.
- The requirements that the public scheme imposes e.g. that the options implemented are verifiable and controllable may be restrictive for a private agent.
- Timeframes for funding may be different for private and public schemes.

Independent or Brokered Purchasing

Within a combined scheme, private agents could either act as entirely independent buyers or the public agency and private agencies could agree to coordinate their buying activities. If acting independently, a combined scheme would present private and public agencies with the opportunity to review farmers' applications and select which applications they wish to finance. Given the requirements of the public scheme, the Managing Authority and/or the Paying Agency would have to play some coordinating role particularly in situations where more than one agent wishes to fund a particular application (to avoid double-funding). Where the benefits of changing farming activities provide a public good, for example by reducing pollution in rivers, free-riding¹¹ problems may arise between the different purchasing agents. In that case the level of financing could be less than optimal.

One way of overcoming these problems would be for public and private funders to coordinate their purchasing. In order to achieve that, a set of purchasing rules would have to be agreed in advance. The rules would define how each agent wanted to see their funds used and how decisions should be made on their allocation under different circumstances. With such a set of rules in place, a (possibly independent) broker would make the decisions on behalf of all agents, taking advantage of possible synergies to choose applications that mean that all agents benefit from the cooperation.

Purchasing Rules

It seems likely that those private agents ready to participate in a combined scheme will be interested in financing a specific subset of the options offered in a public scheme and may be limited to a particular geography.

A number of possible purchasing rules might apply, including:

- The private agent offers a budget and seeks to finance as many agreements as possible that deliver that option in their target region;
- The private agent makes a fixed (percentage) contribution to the costs of all applications that the government decides to finance which deliver the private agent's options in their target region (perhaps up to some predetermined budget cap).

Given the uncertainties associated with environmental change there is also an issue of evidencing outcomes. For example, water companies will wish to see improvements in water quality from funding changes to farming practice but the causal link to actions from specific farms may be difficult to verify. Other private agents may be seeking to strengthen the resilience of their supply chain through the environmental performance of farmer suppliers. Again it may be necessary to use proxies for delivering environmental improvements rather than rely on actual measurements at a farm scale. While individual parties will often take a pragmatic view on the causality between supported actions and outcomes, this is always more complex when there is joint financing as there is less certainty that each party has delivered its end of the bargain effectively.

Public/private models

There are a number of public/private models that could be considered for a joint scheme between Countryside Stewardship and water companies.

- **Parallel schemes with limited coordination:** Private schemes could run completely independently of the public scheme, pursuing their own objectives with specifically designed options, geographic

¹¹ The free rider problem occurs when those who benefit from resources, goods, or services do not pay for them, which results in either an under-provision of those goods or services, or in an overuse or degradation of a common property resource.

focus and payment mechanisms. Coordination would rely on sharing scheme details and events and having representatives on steering groups, for example.

- **Co-ordinated but separate public and private schemes:** Water companies and the public agent coordinate outside the public scheme e.g. Countryside Stewardship funds channelled into targeted schemes co-ordinated by water companies, catchment partnerships or trusted third party brokers.
- **Joint administration of separate public and private schemes (through the public scheme):** Water companies use the administrative apparatus of Countryside Stewardship and specify additional options that they would fund separately from the agri-environment funds. Such a scheme would provide a combined interface to farmers and could extend to a common monitoring and evaluation framework, allowing for further cost sharing.
- **Joint public / private purchasing (within the public scheme):** Water companies and the public agent coordinate within the public scheme apparatus with, for example, particular options being co-funded by the water company and Countryside Stewardship.

4.2 Barriers to and requirements for a public/private model

General barriers to funding land management change

Below we describe the requirements that a model for a joint scheme would need to address from the private and public perspectives. First, we outline some of the barriers expressed during the interviews with the water companies and other stakeholders. While these do not relate to a particular model for a joint scheme, they apply generally to PES and in that sense are in common with the barriers from the perspective of the public agent. These issues and challenges are well known in the PES literature.

- **Additionality:** The term additionality is used to mean the degree of environmental benefit which is secured by a policy over and above that which would have happened anyway in the absence of the intervention. A key issue relates to payments to secure particular management practices or maintain environmental stocks under agri-environment schemes. In some cases, where this management is consistent with the land manager's objectives, there are no opportunity costs for the activity and theoretically no additional benefits from the funding.
- **Polluter pays principle:** This principle dictates that the party responsible for producing pollution is responsible for paying for the damage done to the environment. Many of the water companies expressed concern over whether they, as the direct recipients of the negative externality from agriculture, should pay farmers to reduce pollutants. In addition, the water companies were wary of setting a precedent for a future stream of payments to farmers to reduce a problem not of their making.
- **Free riding:** This relates to situations where some parties can benefit from a good or service without paying anything (or making a contribution less than their benefit) and thus the good or service will be underprovided. Where the benefits from investment in land management options are accessible to all (e.g. carbon) and/or more intangible (e.g. biodiversity) some businesses may shy away from funding actions where the benefits are shared with others. For example, the insurance sector is interested in options to reduce flood risk but the gains from, for example, tree planting are available to all those downstream including householders who can buy their insurance from a range of competing businesses. The exception is where the act of funding *per se* has value in terms of

corporate social responsibility (CSR), which could, for example, relate to businesses investing in the Woodland or Peatland Carbon Code to create a verifiable asset of the carbon savings.

- Strategic behaviour: Linked to the polluter pays principle¹² are issues of potential strategic response to funding on the behalf of private agents, including farmers. These issues are well illustrated with the need to reduce pesticides from water where it was noted that it could be in the sector's interest to demonstrate that it is too difficult and expensive to remove pesticides from water and that the best solution is for the regulator to take them off the market. The flip side of this consideration could be the desire of the agro-chemical companies to maintain the lifetime of their products by contributing to a scheme to reduce use or enhance efficiency of use. In addition, it was suggested that there is potential for moral hazard¹³ to arise i.e. if the land manager knows they can receive funding to reduce the use of specific substances, they may be tempted to use them in order to access the funding.

Private agent requirements

The interviews with water companies highlighted a number of concerns over joint funding of agri-environment schemes:

- Choice of management options available: there was some debate as to the efficacy and appropriateness of the options available in current agri-environment scheme (Environmental Stewardship) in terms of delivering the changes in ecosystem services required. This extends beyond the management prescription and includes option location and timing. Countryside Stewardship may be more attractive and we note the Catchment Wise scheme developed by United Utilities appears to utilise a number of agri-environment like management options (see annex 5);
- Relationship with farmers: both the water companies and food supply chain businesses work directly with farmers within their catchment or supply chain and have established relationships over a period of years. Water companies do not wish to lose this direct contact especially as the location of the ecosystem service provider is key. This is less important for food chain businesses and the issue of losing contact did not come to the fore. Retailers can have long term relationships with farmers but these are associated with shorter term contracts and therefore the provider of the ecosystem service is more dynamic;
- Regulatory environment: The water companies have recently submitted their Asset Management Plans (AMP6) as part of the 2014 price review (PR14). Written into those plans are the water companies' requests for funding catchment management schemes over the period 2015-20. Over this period, the focus for water companies would be through the development of small-scale pilots designed to test the efficacy of such a scheme. The initial statement of principles for PR14 (which occur every 5 years – see <https://www.ofwat.gov.uk/pricereview/pr14/milestones/>) were laid out in May 2012 suggesting that, if a similar process is to occur, such revised principles for PR19 would be laid out in 2017.

¹² The polluter pays principle is enacted to make the party responsible for producing pollution responsible for paying for the damage done to the natural environment.

¹³ Moral hazard occurs when one person takes more risks because someone else bears the burden of those risks.

Public scheme requirements

EU funds can only be disbursed in compliance with a number of conditions to deliver objectives and prevent fraud. The new EU agri-environment programme (2014-2020) requires that management options are *verifiable and controllable* and an ex-ante assessment is required to this end. The guidance fiche¹⁴ on the verifiability and controllability of measures highlights a number of issues relating to the root causes of errors in the implementation of measures. The issues of interest for *Agri-environment-climate* are:

- Commitments difficult to verify and/or control: these can relate to conditions on maximum or minimum livestock densities; actions to be completed by a specific date; actions to be completed at a moment that cannot be defined in advance (e.g. before harvest); reductions in input usage over all or part of a farm. The guidance states that additional care is required to ensure a satisfactory level of verification or control. It further states that the Managing Authority should consider an appropriate combination of IT checks under the administrative checks and on-the-spot checks as a better toolkit for verification
- Pre-conditions as eligibility conditions: Pre-conditions such as minimum livestock density need to be verified at the application phase to include or exclude the beneficiary from the support. This “yes-no” condition is subject to 100% withdrawal of support in the case of non-compliance.
- IT systems: these are important to minimise risks and improve controllability and verifiability of the measures and can support any stage of the grant cycle. They can include information, payment claims, document submission, alert systems, checks and controls etc.
- Payment claims: In addition to the verifiability and controllability requirements, the amount that can be paid for a management option is required to be no more than additional costs and income foregone. The calculations for these must be “adequate and accurate and established in advance on the basis of a fair, equitable, and verifiable calculation”.

Discussion of barriers

A number of the barriers mentioned by the water companies have parallels with concerns expressed by public funders in terms of ensuring value for money from an agri-environment scheme. The first two of the verifiability and controllability issues for EU funding address some aspects of free riding and moral hazard by requiring sufficient evidence regarding baseline conditions and proof of activities. Whether this assuages concern from the private stakeholders will depend upon the actual systems in place for those commitments that are difficult to verify and pre-conditions for eligibility.

For the water companies, an assessment of investment in improving water quality (and their responses driven by AMP6) is based on securing tangible outcomes and may not necessarily be true for other private agents. A joint public/private scheme with water companies relies on an economic case in absolute or relative terms while the public agent would need an absolute or relative gain in environmental quality and value for money in terms of expenditure.

The timescales required by the water companies (in terms of longevity of the phases of the Upstream Thinking projects for example) are of the same order as for the public scheme. Given that the ecosystem service (water quality) is tangible and location specific, the commitment would be ongoing while the management options maintain their relative cost effectiveness. For other potential PES

¹⁴ Activity report Document 15 from the EU Expert Group for Rural Development (E02732)

<http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2732&NewSearch=1&NewSearch=1>

stakeholders, the focus for investment could be more transitory e.g. due to the emergence of alternative options or to a change in business strategy, ownership, or fortunes. Such changes in circumstances may also apply to the public funder e.g. in response to changes in policy priorities or availability of funding over time.

The income foregone requirements may limit uptake by a critical mass of landowners where the cost of participation is greater than an individual's income foregone, undermining impact at catchment level. Also, some catchments may have costs associated with management options that are higher than the public scheme rates and could make a joint scheme unworkable. Interestingly an auction approach to allocating funding might usefully address this issue of variable cost of participation, provided the income foregone payment rates can be exceeded.

Overall, the barriers noted are consistent with a recent report for the Welsh Government (Cascade Consulting, 2014) which engaged with stakeholders on PES and other mechanisms. The analysis concluded that buyers will be convinced of the benefits from a PES approach if they can see that a scheme will:

- reduce current costs of production (e.g. for water companies provide a cost effective solution compared to end of pipe treatment costs);
- avoid current and future risks for the business; and
- improve relations with consumers and enhance brand value and reputation.

The barriers discussed relate to those businesses that are ready to engage with PES. As revealed in the discussions with other sectors, some have an interest in the concept but are still within the learning phase; for these the main barrier is one of information and engagement. We come back to this point in the closing comments of this section.

Potential Issues with the Models

The models for public/private funding introduced in section 5.1, are reviewed below in terms of the barriers and requirements outlined above.

Co-ordinated but separate public and private schemes: This model would require some mechanism capable of coordinating funding and activity. Governance models applied within Upstream Thinking and Catchment Wise could be of interest here in that they include a wide group of local stakeholders and in the case of the Exmoor Mires project (in Upstream Thinking), agreed plans were incorporated into existing or newly negotiated agri-environment agreements. Both private and public funders should be able to demonstrate greater environmental (and financial) benefit than would be achievable acting alone.

Joint administration of separate public and private schemes (through the public scheme): This cost sharing approach may not necessarily lead to sufficient reduced costs to warrant progressing. The private agent may prefer to retain some form of direct contact or “badging” with the land managers and the flexibility of a differ set of management options, both of which might reduce potential cost savings. The risk of payment problems linked to EU rules may also deter private businesses from joining a single administrative system.

Joint public/private purchasing (within the public scheme): A particular limiting factor for a joint purchasing model is the EU funding rule on income foregone. It may be that the water companies can top up funding in areas where farmers' costs are higher than the typical costs as estimated for the public scheme. However, it would be necessary to demonstrate that such payments are “adequate and accurate and established in advance on the basis of a fair, equitable, and verifiable calculation”. This might entail substantial local effort and administrative burden on behalf of the scheme funders. For a

number of management options the public scheme payment has been less than 100% of the estimated typical income foregone. This creates the possibility that the private agent could pay the balance without breaking public scheme rules. The extent to which income foregone issues are surmountable within a joint purchasing model are possible within the requirements of the EU scheme needs to be explored further.

4.3 Policy development

A model for public/private PES funding

The “traffic lights” matrix in Table 13 shows the project team’s best estimate of whether the models described address the private and public barriers identified. This simple overview of the basic models against the requirements suggests the coordinated purchasing would seem to offer greater scope for advancing a joint public/private PES scheme. It is reassuring that this model has much in common with existing models being trialled by the water companies within Catchment Wise and Upstream Thinking.

Table 13: Models for bringing public and private funding together for agri-environment schemes

| | | Coordinated purchasing | Joint admin only | Joint purchasing |
|--------------------------------|-----------------------------|--|--|---|
| Requirements of private agents | Option choice | Private agent can design and administer own options. | Private agent can design own options but these would need to be captured by the public administration. | Limited to public scheme options only within EU rules. Using additional options would require a parallel procurement process. |
| | Farmer contact | Shared roles to maintain contact for both parties? | Potential loss of contact by private agent | Could be lost but option for joint badging? |
| | Administration | Potentially more efficient / effective coordinated delivery. | Admin. Likely to be more complex but total costs should be reduced. | Income foregone rules may limit ability to apply at sufficient scale to show cost effectiveness. |
| EU rules | Verifiable and controllable | No impact on private options | No impact on private options | Common for both public and private schemes but may be issues of definition. |
| | Income foregone | No impact on private options | No impact on private options | Lack of flexibility for private agent to pay above typical costs of participation. |

Key:

| | |
|--|---|
| | Model can fully address the requirements |
| | Model can only partially address the requirements |
| | Model cannot address the requirements |

Mainstreaming public/private PES funding

To move this concept forward there is a need to both extend and develop the engagement of the private sector and to build it into the design of the post-2020 RDP. The Defra PES Pilot Studies have shown that buyers can be engaged with specific local schemes but this is more difficult to achieve when discussing such issues more generally and in conjunction with agri-environment schemes. Whilst there is general interest in the ideas, there is a need to provide further detail to potential buyers to more fully engage and for them to be able to see the potential more clearly.

With regard to increased and early engagement of institutions with an interest in private funding for PES, we suggest that government considers recruiting leading companies to contribute to policy development in this area, including shaping the post-2020 RDP design. This parallel development of private and public funding elements is key to launching a coordinated public/private PES funding model in the next iteration of Countryside Stewardship.

In the interim, a number of actions should be taken:

- Explore the scope for coordination of existing PES private and public schemes, using the water companies as a test-case.
 - Review the scope and efficacy of Countryside Stewardship options targeted at water quality and their ability to deliver water company objectives at a local catchment scale.
 - Identify overlaps and consider how existing water company initiatives can complement the public scheme and improve effectiveness and value for money through better coordination.
- Develop a common framework for governance, operation and evaluation of coordinated private and public PES.
 - Explore and qualify the legal basis for integration of agri-environment funding with private funding.
 - Consider the use of Countryside Stewardship spatial priorities and targeting as a framework for highlighting private/public PES funding opportunities.
 - Scope the roles of intermediaries (facilitator/broker) and stakeholders in facilitating public/private PES funding schemes and the 'rules of engagement'.
 - Assess the scope for shared data between public and private schemes (e.g. metrics and Indicators of Success) and also common processes (e.g. monitoring and evaluation) and how convergence on these might facilitate better joint working and reduce costs.
 - Adopt a transdisciplinary approach and employ co-design/co-development to ensure any model is fit for purpose.
 - Set out a roadmap for the three categories of private agents – PES ready, Investors in ecosystem services and PES interested – to engage with PES policy.
 - Engage with potential funders to scope complementary and overlapping aims and actions – what would they get involved in and how?
 - Recruit a PES panel as observer for auction pilots, post-2020 RDP design and wider policy.

5 Proposals for piloting reverse auctions

Learning from the scoping work

In considering proposals for piloting reverse auctions, it is important to build on the evidence that has been developed in this project and to refer back to the primary motive for the work, notably securing improved value for money for public expenditure in this area.

The simulation modelling conducted at UEA provides a number of insights into the impacts of various elements of auction design for the purposes of allocating agri-environment contracts. More broadly the data suggest that a discriminatory price auction (where participants get paid what they bid) provides 15% better cost-efficiency than an alternative scheme which offers a fixed price set around the centre of the cost distribution. The mechanism for this 'efficiency gain' is based on a balance between encouraging enough people to participate in the auction and ensuring that they base their bids on their cost of participation (including transaction costs). This relies on appropriate auction design and would be the focus for piloting reverse auctions.

Evidence from the farmer workshops demonstrated that while farmers found the concept of pricing bids challenging, they could participate in the auction process if sufficient information and guidance was provided. In the workshops, farmers found feedback on the VFM of winning bids from previous auctions particularly useful and this is consistent with the experimental work. Farmers also tested the principle of a Pick and Mix auction format to bid for multiple options.

Key recommendations for auction pilots include:

- Countryside Stewardship should be in place ahead of auction pilots
- The platform for bidding should be easy to use
- The environmental scoring element should be transparent and robust
- The role of information on previous successful bidding rounds, guide prices etc. should be tested
- The pilots should explore opportunities for farmers to combine options (if possible)
- The pilots should explore the impact of longer timescales on participation and VFM

The wider case for leveraging additional funding from the private sector through the PES principle is in many respects a linked but parallel workstream which also needs to be taken forward. Together these two components can potentially offer a greater overall budget and efficiencies in how that funding is deployed. However, the basis for integrating public and private funding is not a primary priority at this point and we recommend that it is first necessary to pilot the reverse auction as a funding mechanism. This chapter explores some of the key considerations for implementing pilot auctions with farmers.

Priorities for reverse auctions pilots

The experimental auctions and simulation modelling have provided valuable evidence on auction design options. On the basis of this work we suggest the following priorities for piloting reverse auctions for Countryside Stewards funding in a Mid-Tier:

1. A discriminatory price auction (where participants get paid what they bid). Within this the following elements should be explored:
 - a. provision of feedback
 - b. guide prices
 - c. Pick and Mix vs. All or Nothing format
2. A landscape-scale target auction, to include research on the use of a Follow-Up auction format.

Participants for reverse auctions pilots

It is evident that moving from the current open access agri-environment scheme under Environmental Stewardship to a competitive funding environment under Countryside Stewardship and simultaneously testing an auction mechanism risks some conflation of the latter elements. As such, the timing of pilots should ideally allow for a settling-in period after the new scheme is launched. However, once the new scheme is implemented (from January 2016), securing participants for pilot auctions may prove difficult – they would only take part if they had some guarantee that they would not be any worse off (e.g. lower payment rates than under CS or failure to secure an agreement agreement) – which might prove complex and expensive.

Nevertheless, there are some groups that might be used for piloting on the basis that they cannot participate in the new Countryside Stewardship scheme in the next few years. These include:

- i. Farmers who exited ELS in 2014 due to double-funding issues with Greening requirements for CAP Pillar I funding and have not applied for CS;
- ii. Farmers who applied for CS in 2015 (or subsequent years) but were unsuccessful;
- iii. Farmers with an existing ES agreement but offered the opportunity to add additional options under CS.

It would seem that the third group offers the most potential as this represents a large number of agreement holders, and is not biased in being disengaged (as group i) or unsuccessful applicants for CS (as group ii) where there may be eligibility issues. The main limitation is the extent to which this constrains the options which can be tested and/or the extent to which these farms have ‘saturated’ their demand for the scheme e.g. all land which is less productive for agriculture has already been included in ELS options. Given the substantial population, a suitable sample should be available.

Sample size and selection for pilots

The key requirement for piloting reverse auctions as outlined above is a representative sample on a scale which can provide robust evidence on the efficiency gains or increased value for money that can be secured. While the sample needs to be representative of the relevant population (those participating in ES), there are trade-offs in accommodating variation in farm type, farm size etc and the need for a larger sample. We recommend that three groups are captured in the pilots to represent the main farming systems and contexts as defined by robust farm types (RFT), namely arable farms (RT1 – CEREALS and RT2 - GENERAL CROPPING), lowland livestock farms (RT6 – DAIRY and RT8 - LOWLAND GRAZING LIVESTOCK) and upland livestock farms (RT7 - LFA GRAZING LIVESTOCK). Within this framework, a range of options can be accommodated.

Given the heterogeneity within the farming population – by scale, sector and cost distribution – it may be best to consider an overall sample which is treated as a single entity to compare an auction approach against fixed prices but can accommodate cross-tabulation analysis by these criteria. For each, a total sample of 150 farms¹⁵ would provide a confidence interval of +/-8% at the 95% confidence level for each ‘treatment’ and a sub-sample of 50 farms for each farm type. On the basis that this would be matched by a similar sized counterfactual sample (randomly assigned), that would require a total sample of at least 300 farms.

¹⁵ Based on the Fowey River Improvement Auction (<http://cserge.ac.uk/research/current-projects/fowey-river-improvement-auction>) where collusion was not an issue, we suggest that a sample of 150 farmers per group is sufficient to ensure farmers felt they were in competition for funding. For a “statistically robust sample” the probability of success should be similar in the pilot as it would be in the full-scale scheme and farmers recruited into the pilot should be a representative sample of the farmers that might participate in the full-scale scheme.

Table 14: Sample size and confidence interval

| Sample size | Confidence level 95% | Confidence level 99% |
|-------------|----------------------|----------------------|
| 50 | 13.9 | 18.2 |
| 100 | 9.8 | 12.9 |
| 150 | 8.0 | 10.5 |
| 200 | 6.9 | 9.1 |
| 250 | 6.2 | 8.2 |

In recruiting the sample it may be necessary to screen for those that (a) are not interested in taking up any additional CS options and (b) those that have no capacity to do so, in order that the number of maximum number of positive responses are secured in the counterfactual sample.

It may be advantageous in the pilot program to explore mechanisms to increase participation. For example, this may include the provision of training opportunities to unsuccessful bidders, bonus payments for bid lodgement, or feedback on bids that may be useful in bid rounds. If up to two-thirds of bidders may be unsuccessful, some additional inducements may be required to generate ongoing levels of participation.

Which CS options to pilot

Not all Countryside Stewardship options are relevant to the three farm type/context groups set out above, although some common options will apply. Ideally, the pilots would focus on a limited number of themes, for example to represent the key environmental priorities for CS, namely biodiversity and water quality. Some possibilities are set out below on the basis of contexts and theme.

Table 15: Possible CS options for use in reverse auction field-scale pilots

| Theme | Arable | Lowland livestock | Upland livestock |
|---------------|---|---|-------------------------------|
| Biodiversity | Autumn-sown Bumblebird mix (AB16) | Legume and herb-rich swards (GS4) | Enclosed rough grazing (UP1) |
| Water quality | Arable reversion to grassland with low fertiliser input (SW7) | Management of intensive grassland adjacent to a watercourse (SW8) | |
| Landscape | | | Stone wall restoration (BN12) |

The options are based on a trade-off between options which might be popular or well-funded and will attract competition for agreements and options which are not already well-represented in existing ELS agreements. For example, SW7 was previously only available in HLS while AB16 and SW8 are new in CS.

Some types of option may be more suited to an auction approach than others e.g. where continuity at a site is not critical and where outputs are tangible. Ultimately, the decision may also be shaped by the category of participants targeted. For example, farmers with existing ES agreements could only be offered additional options which they do not already have. For evaluation, it might be helpful to trial only a limited number of options which all participants are offered and on this basis, options new to Countryside Stewardship may be preferable.

Timescales for pilots

A number of discrete steps in the establishment and running of pilots are envisaged as follows:

1. Agree the design options to be tested and target population
2. Recruit a statistically robust sample of farmers.
3. Research the sample (cost distribution, transaction costs, capacity to participate etc.) prior to running in the pilot
4. Develop and trial a platform for operating the auction to ensure functionality and utility
5. Trial the auction design options. It may also be helpful to run the pilot over successive years to test learning.
6. Report the pilots and make recommendations on their use in agri-environment schemes.

As such we recommend that a phased approach is taken over a period of 2-3 years to provide robust evidence on the economic case for introducing reverse auctions as a delivery mechanism for Countryside Stewardship. At each stage if problems are found e.g. failure to secure participation, absence of economic efficiency in practice or risks to achieving environmental objectives, there would be an opportunity to draw the work to a close.

Evaluation framework

To measure the additional VFM from using auctions, it is necessary to compare against the standard CS fixed price approach (counterfactual). This presents a challenge as there is a live scheme. Options include:

- i. Ask pilot participants to complete an application for the standard CS scheme;
- ii. Where failed CS applicants are recruited, this data would already be available;
- iii. Recruit a larger sample and randomly assign to a fixed price or auction group.

The main design challenge is what basis to use for measuring the performance of these auctions and design variants at a field scale. This counterfactual could be a control group which is asked to bid under a fixed price system. Alternatively the pilot farmers could be asked to bid under both mechanisms but there is a risk of learning affecting the outcome. We recommend option (iii) above, namely recruiting a larger sample and randomly assigning half to a fixed price group and half to an auction group.

The evaluation should follow accepted evaluation protocols e.g. the Magenta book (<https://www.gov.uk/government/publications/the-magenta-book>). Key issues for the reverse auction pilots include:

- Defining and recruiting the participant and counterfactual sample (given the live Countryside Stewardship scheme from 2016).
- Dealing with representativeness and selection bias in the sample (both reverse auction and counterfactual groups), allowing for heterogeneity within the population.
- Timescales for securing the sample, establishing the pilots and undertaking the evaluation.
- Selection of Countryside Stewardship options to be used in the pilots.
- Quantifying value for money of reverse auctions relative to a fixed price approach and scaling up to a country level.

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