4th AIEAA Conference

*"Innovation, productivity and growth: towards sustainable agri-food production"*

ASSOCIAZIONE ITALIANA DI ECONOMIA AGRARIA E APPLICATA

# “Agri-environmental payments in Europe, USA and Australia: empirical evidence from auctions and contracts”

**Vergamini Daniele**[1], Benedict White[2] and Davide Viaggi[1]

[1] University of Bologna/Department of Agricultural Sciences, Bologna, Italy
[2] University of Western Australia/School of Agricultural and Resource Economics, Perth,

daniele.vergamini@unibo.it

11-12 June, 2015
Ancona, Italy

# Outline

- Objectives
- Background
- Methodology
  - Contract model
  - Auction model
- Case study and results
- Discussion

# Objectives

1. Simulate a menu of contracts and a one-shot procurement auction with FADN data 2012 in Emilia-Romagna Region (ERR)

2. Compare the contract and auction methods to flat payment for improving cost-effectiveness of agri-environmental payments (AEP)

3. Draw lessons about policy design options in EU, AUS and US for reducing information rents in real life

# Background (1)

Common features (Ozanne and White, 2008) of AEP in EU, AUS, US:

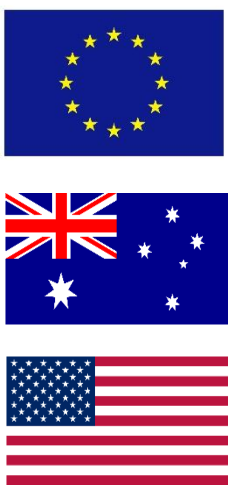
1. Participation involves agri-environmental agreements that must specify expected outcomes, benefits and level of payment

2. Presence of information asimmetries giving rise to:

    1. **Hidden information or adverse selection** *(Chambers, 1992; Wu and Babcock 1996; Latacz-Lohmann and Van der Hamsvoort, 1997; Moxey et al., 1999; White, 2001)*
    2. **Hidden action or moral hazard** *(Choe and Fraser, 1998, 1999; Ozanne et al., 2001 and Fraser, 2002).*

# Background (2)

AEP design



Target based on costly-to-fake signals

Good when correlations between signals and farmers are strong; information can be costly;

***Field examples***: differentiated payments, targeting approach or zoning systems

Screening contracts

Powerful theoretically;
Technically challenging;
***No field examples.***

Procurement auctions

Requires competition to achieve rent reduction; uncertainty with repeated format;

***Field examples:*** *US CRP, AUS Bush Tender, Eco Tender, ALR*

# Methodology: Auction

***Auction model:*** *Latacz-Lohmann and Van der Hamsvoort (1997), Viaggi et al. (2008)*

**AUCTION RULES:**

1. multiple units of AEM1
2. Bid (*b*) for a different level of activity
3. heterogeneity in costs
4. budget constrained (*B*)
5. *no cost* - payment is only function of the bid and farmers are risk neutral

When $\underline{\beta}$=0 **the optimal bid becomes:**

$$b^*(\tau)=\max\left[\frac{1}{2}\left(k_t(\tau)+\overline{\beta}\right),\underline{\beta}\right]$$

**Farmers offer a bid if:**

$$U(\Pi_1+b)\cdot[1-F(b)]+U(\Pi_0)\cdot F(b) > U(\Pi_0)$$

NB. expectations are uniformly distributed in the range $[\underline{\beta},\ \overline{\beta}]$

$k(\tau)$ the cumulative compliance

$k_t(\tau)=\Pi_0(\tau)-\Pi_1(\tau)$, the marginal cost

$$TC=\left[\frac{1}{2}\left(k(\tau)+\overline{\beta}\tau\right)\right]\le B$$

*Comprehensive literature* (McAfee and McMillian, 1987; Milgrom, 1985; Klemperer 2000)

# Methodology: menu of contracts

***Principal-agent model:*** Laffont and Tirole (1993), Moxey et al. (1999)

**HYPOTHESIS:**

1. two farm types (i=low "l", high "h")
2. Payment for input reduction measure (AEM1)
3. Principal has no knowledge of site-specific production conditions
4. Farmers choose traditional farming practice vs compliance with agri-environmental measure (profit $\Pi_{trad}$ and $\Pi_{AEM1}$)

**Perfect information**

defining a contract that offer to farmers the payment coupled with the input reduction $[s_i^p, x_i^p]$ with $x_h^p > x_l^p$

**Asymmetric information: adverse selection**

Low productivity type 1 has an incentive to declare themselves as the high productivity type 2 and obtain: $[(x_h, s_h)]$

*The government expenditure is increased to* $\boxed{2s_h^p > s_l^p + s_h^p}$ *with* $s_l < s_h$

**Second-Best Asymmetric Information**

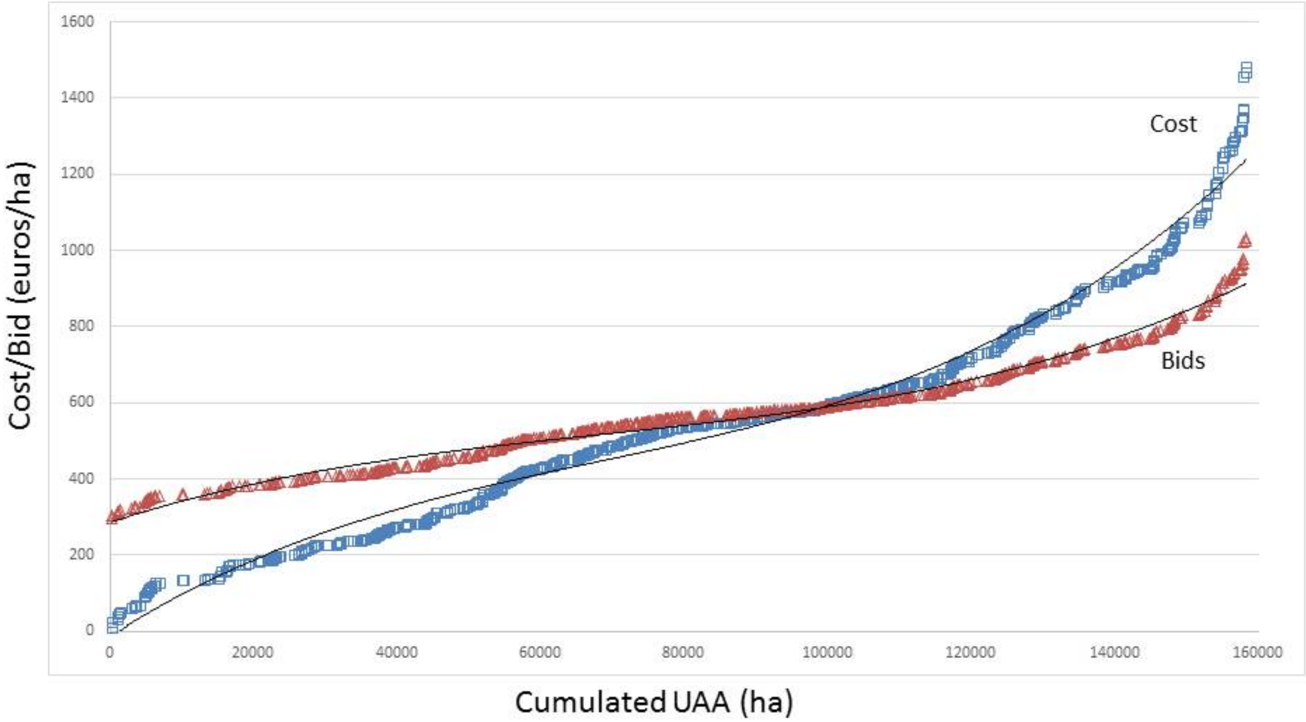
$[(x_l^a, s_l^a);\ (x_h^a, s_h^a)]$ $\boxed{\text{with } x_l^a = x_l^p,\ x_h^a > x_h^p \text{ and } x_h^a > x_l^a \text{ and } s_l^p < s_h^p < s_l^a < s_h^a}$

**Objective:** **Maximize social welfare**

(finding the optimal contractual arrangement)

# Case study: Auction

***Figure 1**. Cost and bid as a function of participating UAA  (AEM1)*




1. Compliance cost function is derived from FADN data for ERR 2012
2. Consider 512 farmers that cultivate wheat in 2010-2011
3. $\underline{\beta}$=0  and $\overline{\beta}$ =average of the payments for the AEM1 in the RDP ERR 2000-2006

# Case study: Menu of Contracts

**Contract hypothesis**

1. input reduction measure (first attempt of an empirical simulation)
2. due to data constrains production technology from Moxey and White (1999) and Ozanne and White (2008)
3. y=$A_i x^{\beta}$ (x nitrogen input)
4. better approach would be the continuum of types

***Table 1.*** *Simulation excercise data input*

| Parameters | Symbol | Value |
|---|---|---|
| Low productivity land | A1 | 0,90 |
| High productivity land | A2 | 1,15 |
| Production function slope | β | 0,350 |
| Output price (Euros/per tonne wheat) | P | 190 |
| Input price (Euros per kg nitrogen) | W | 2.3 |
| Profit maximizing input: | | |
| *Low productivity land* (kg per ha) | $x_1^*$ | *151.75* |
| *High Productivity land* (kg per ha) | $x_1^*$ | *220.85* |
| *Probability of Type i=1* | $\gamma$ | *0,5* |

# Results: Auction

***Table.1*** Percentage of total UAA of wheat in ERR participating in AEM1 within two budget scenarios (low budget and high budget).

| **Instruments/Budget scenario** | **% of total UAA of wheat** with low budget 0.25 million of euros | **% of total UAA of wheat** with high budget 2 million of euros |
|---|---|---|
| *Marginal Payment* | 2,62 | 10,61 |
| *Auction* | 0,62 | 3,78 |
| *Flat rate payment* | 0,16 | 2,26 |

Source: own elaboration.

# Results: Menu of Contracts

***Table.2*** Contract model preliminary results

| **Scenarios** | **Input Quotas** | | **Transfer Payment** | |
|---|---|---|---|---|
| | x1 | x2 | s1 | s2 |
| *No Policy* | 151.75 | 220.85 | | |
| *First-Best Perfect Information* | 64.1 | 93.2 | 58.0 | 84.5 |
| *Asymmetric Information adverse selection* | 93.2 | 93.2 | 84.5 | 84.5 |
| *Second-Best Asymmetric Information* | 87.0 | 73.13 | 109.2 | 125.8 |
| *Undifferentiated contract (flat rate)* | 78.49 | 78.49 | 81.46 | 81.46 |

# Discussion and Conclusions

1. Potential to develop market instrument (auction) for the EU AEP
2. Auctions and contracts have the potential to reduce farmers' information rent compared with a flat rate payment mechanism confirming the results of Moxey at all. (1999) and Viaggi et al. (2008).
3. The variability of compliance costs seems to justify the application of complex contract mechanism

*Several weakness:*

- **only two types of farmers**
- farmers' expectation, budget, transaction costs **only indirectly modelled**
- **environmental outcomes**
- **introduce the monitoring**

*Further development:* **continuum of farmers**

# Thank you!!

daniele.vergamini@unibo.it

# Auction model

**AUCTION RULES:**
1. multiple units
2. bid for a different level of activity
3. heterogeneity in costs
4. budget constrained (def. max bid cap $\underline{\beta}$)
5. no cost - payment is only function of the bid and farmers are risk neutral

**Farmers offer a bid if:**

$U(\Pi_1 + b) \cdot [1 - F(b)] + U(\Pi_0) \cdot F(b) > U(\Pi_0)$

NB. expectations are uniformly distributed in the range $[\underline{\beta}, \overline{\beta}]$

**The optimal bid is determined by:**

$b^* = max\left[\frac{1}{2}(\Pi_0 - \Pi_1 + \overline{\beta}), \underline{\beta}\right]$

$s.t.\ b^* > \Pi_0 - \Pi_1$

$k(\tau)$ the cumulative compliance

$k_t(\tau) = \Pi_0(\tau) - \Pi_1(\tau)$, the marginal cost

When $\underline{\beta}=0$ **the optimal bid becomes:**

$b^*(\tau) = \max\left[\frac{1}{2}(k_t(\tau) + \overline{\beta}), \underline{\beta}\right]$

$TC = \left[\frac{1}{2}(k(\tau) + \overline{\beta}\tau)\right] \leq B$

$\tau^* = \left[\frac{2B - k(\tau)}{\overline{\beta}}\right]$ $\qquad \tau^*_{MFR} = \left[\frac{B}{k_t(\tau)}\right]$ $\qquad \tau^*_{AVG} = \left[\frac{B}{P}\right]$

# Contract model (1)

- Principal-agent relationship
- Payment for input reduction measure
- two farm types (i=1,2)
- the principal has no knowledge of site-specific production conditions
- traditional farming practice vs compliance with agri-environmental measure (profit $\Pi_0$ and $\Pi_1$)

$\boldsymbol{s_i}$ the AE payment

**(1+e)** is the cost of transfer payments

$\boldsymbol{\delta}$ measure the benefit per hectares of enrolled area under the measure

$\boldsymbol{x_i^*}$ is the optimal unconstrained input

***Perfect information***

**Max**

$\Phi_i(b_i, x_i)=\delta a_i+(s_i - k_i(x_i))$-(1+e) $s_i$

with $a_i=(x_i^*-x_i)$

***S.t.***

$s_i^p$-$k_i(x_i^p) \geq 0$ [individual rationality constraint]

$$-(1+e)k_i'\left(x_i^p\right) = \delta$$

defining a contract that offer to farmers the payment coupled with the input reduction $[s_i^p, x_i^p]$ with $x_2^p > x_1^p$

# Contract model (2)

***Perfect information vs Under Asymmetric information (adverse selection)***

- Low productivity type 1 has an incentive to declare themselves as the high productivity type 2 and obtain: $[(x_2, s_2)]$
- *The government expenditure is increased to* $2s_2^p > s_1^p + s_2^p$ *with* $s_1 < s_2$

**Second Best (*Asymmetric* information):**

$Max\ \Phi = \gamma[\delta(\mathrm{x}_1^* - \mathrm{x}_1^a) + (s_1^a - k_1(\mathrm{x}_1^a)) - (1+\mathrm{e})\, s_1^a] + (1-\gamma)[\delta(\mathrm{x}_2^* - \mathrm{x}_2^a) + (s_2^a - k_2(\mathrm{x}_2^a)) - (1+\mathrm{e})\, s_2^a]$

s.t.

$IC1 = s_1^a - k_1(\mathrm{x}_1^a) > s_2^a - k_1(\mathrm{x}_2^a)$ [Incentive compatibility constraint 1,2]

$IC2 = s_2^p - k_2(\mathrm{x}_2^a) > s_1^a - k_2(\mathrm{x}_1^a)$

$IR1 = s_1^a - k_1(\mathrm{x}_1^a) \geq 0$ [Incentive rationality constraint 1,2]

$IR2 = s_2^a - k_2(\mathrm{x}_2^a) \geq 0$

__Solution__: offer a contract $[(\mathrm{x}_1^a, s_1^a);\ (\mathrm{x}_2^a, s_2^a)]$

with $\mathrm{x}_1^\mathrm{a} = \mathrm{x}_1^\mathrm{p}$, $\mathrm{x}_2^\mathrm{a} > \mathrm{x}_2^\mathrm{p}$ and $\mathrm{x}_2^\mathrm{a} > \mathrm{x}_1^\mathrm{a}$ and $s_1^p < s_1^p < s_1^a < s_2^a$

$$-(1+e)k_1'(\mathrm{x}_1^a) = v$$

$$-(1+e)k_2'(\mathrm{x}_2^a) = v + \frac{\gamma}{1-\gamma} e[k_2'(\mathrm{x}_2^a) - k_1'(\mathrm{x}_2^a)] < \mathrm{v}$$