Farmers' participation in water allocation trading: A case study in Southern Spain

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In this research farmers' stated preferences towards water markets are analysed. The research aims to underline determinants of farmers' attitudes towards allocation trading considering two water availability scenarios: average and drought year. A survey with 241 farmers in Guadalquivir and Almeria basins is used. Determinants of monetary value of water traded are analysed by means of Heckman's two-steps model. Results indicate that participation increases when farmers belong to innovative type, have agricultural training and cultivate higher crops value. Additionally, low water supply guarantee and appropriate information on seasonal water availability increase probability of participation.

1. Introduction and Objective

In water-scarce regions, water allocation is still mainly based on historical water demand. However, increasing demand and periodic water shortages have led to the establishment of new forms of demand management. An example is water trading, which is intended to make water allocation more flexible, and is seen as an efficient method to allocate scarce water resources to the most productive uses (World Bank, 1997). Chile, the USA and Australia already have a long experience with irrigation water trading, and it has been introduced more recently in Alberta (Canada), China and South-Africa.

In Europe, irrigation water trading is still mostly a research and policy discussion topic. It is included in the research agenda of the European Union Commission as a reliable policy instrument, "[...] *which could help to improve water efficiency and overcome water stress, if a sustainable overall cap for water use is implemented*" (EC, 2012). However, to date there is only one European country with an established legal framework and experience for water trading: Spain.

The Spanish Water Law was reformed in 2005 to allow holders of water rights to trade them on a temporary as well as a permanent basis. However, up until now trading has been rare, has mainly occurred under drought conditions and the traded volume has been limited (Hernández-Mora and De Stefano, 2013).

The achievement of a plenty operative water markets requires deeper knowledge of the factors affecting farmers' acceptance. As argued in Giannoccaro et al. (2013) mathematical models of water trade have been widely used due the absence of real market data, though empirical evidence does not reveal the same extent that theoretical and simulation works seem to anticipate. Therefore, research efforts should be made in order to underline farmer's behaviour and how structural, socio-economic, and climatic factors would influence farmer's participation in water trading.

This research seeks to identify the profile of irrigators in the Guadalquivir and the Almanzora river basins (Southern of Spain) who would use water markets as an innovative management tool to copy with water shortage. A survey conducted in 2012, including a contingent valuation exercise is used. Farmers were asked to express their willingness to purchase and to sell irrigation water in a hypothetical seasonal market, both under normal water availability and drought conditions. The market value of irrigation water is calculated while the supply and demand curves is constructed according to farmers' responses.

2. Materials and Methods

The analysis was carried out for the Guadalquivir and the Almanzora River Basins. The former is the largest irrigation area in Spain, while the latter is home to the most profitable irrigation agriculture in the country, with a high concentration of greenhouses and high value crops. Together they represent roughly 25% of Spain's irrigated area.

The irrigated area in the Guadalquivir Basin comprises 845,000 ha, covering olive groves, fruit orchards (mainly citrus and peaches) and general field crops, such as cotton, maize, sunflowers and, of minor importance, sugar beet. Overall available water resources amount to 3,362 hm^3/year, while net demand in 2008 raised 3,578 hm^3 and 2,981 hm^3 was for irrigation.

The Mediterranean River District extends from the Strait of Gibraltar to the Almanzora River, covering the Mediterranean coastal area of Andalusia. Accordingly, urban water use makes up 21% of water demand in the district, while irrigation uses 73%. Industrial water use is of only minor importance. Total demand in 2008 was 1,157 hm^3. On average, 4,925 m^3 of

irrigation water is applied per hectare on an irrigation system characterised by high value, mainly greenhouse crop production.

An inter-basin transfer system was built to connect the Guadalquivir River Basin to the Almanzora Basin. This allowed the inter-basin transfers under 2006-2007 drought conditions.

In light of this, we considered a variety of item in order to build up different market scenarios. According to the last reformed Spanish law, two market typologies were given, namely an allocation market (leasing of water allocation) and a water right market (permanent transfers of water right). Holders and non-holders of a water right were equally arranged. Moreover, we supposed inter-basin transfers as well as intra-basin transfers. We limited the market agents to farmers. First of all, a normal against reduced irrigation water availability were supposed. A same agent was allowed to sell and/or buy irrigation water on the market. In the case of allocation trading, we established two fixed tradable volumes per hectare: 500 and 1,000 m^3/ha per year. The volumes are per hectare since water allocation is linked to land holdings. All other external variables were assumed invariable. The starting price and volumes in the auctions are in line with observed figures from 2006-2007 transactions.

A survey was conducted with 241 farmers in spring 2012. Of the 241 administered questionnaires, 196 contained valid observations for the market section; 150 within the Guadalquivir Basin and 46 within the Almanzora Basin.

Farmers were asked to express their willingness to purchase and to sell irrigation water in a hypothetical seasonal market, both under normal water availability and under drought conditions.

Before the WTP and WTA questions, farmers were asked whether they agreed with water trading in general, if they would want to sell and/or buy, whether they agreed with trading on a temporary or a permanent basis, and if they were in favour of inter-basin and/or intra-basin trading. An auction simulation was conducted with those farmers who agreed with water trading in general. Questions about buying and selling were asked separately, depending on farmers' stated willingness to do either or both. The survey combined both closed and open-ended WTP and WTA questions. We started with a closed bid of 0.18 EUR/m^3 and according to the farmer's response the price was increased or decreased by 33% (0.24 or 0.12 EUR/m^3, respectively). In the event that farmers either refused or accepted all bids they were asked their maximum WTP and/or minimum WTA. An example of an auction simulation can be seen in the figure 1.

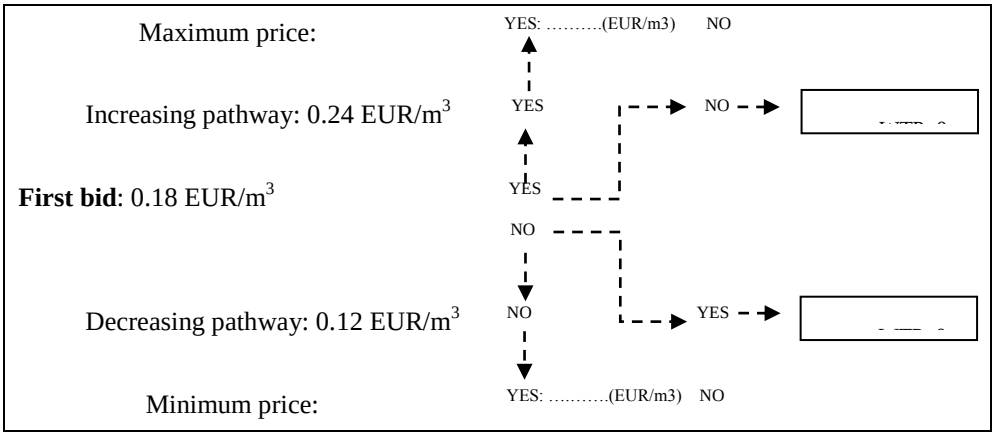

Figure 1. Sequence of CV questions (WTP).

The survey data are analysed in two ways: an econometric model first analyses which variables influence farmer's choice towards the participation in a hypothetical water market while the determinants of WTP/WTA monetary values are estimated in a second model. Indeed, Heckman's two-steps model is applied.

3. Results

Regarding attitudes towards water markets, 45% of respondents agree with trading through both inter-basin and intra-basin markets; 27% are only in favour of trading within the same basin; and 28% are against any type of water trading. Comparing the two areas, a majority of Almanzora farmers only want intra-basin trading, while the majority of Guadalquivir farmers are indifferent to the scale. Objections to water trading are much more common in the Guadalquivir Basin. The main motivation for objecting is the view that water is not a commercial good (100% of those against within the Guadalquivir Basin and 76% within the Almanzora District).

Table 1 presents farmers' responses to the WTP and WTA questions. There are big differences between the basins. In the Guadalquivir Basin more farmers would sell than buy water allocation in a normal year (i.e. the baseline situation), while the reverse is true for drought years. This difference between normal and drought years is not found in the Almanzora Basin, but farmers there are generally more willing to trade (buy and sell).

The equilibrium market price increases from 0.17 EUR/m^3 in the baseline scenario to 0.21 EUR/m^3 under drought conditions. We also find a threshold volume under which start-up costs for irrigation infrastructure make it unprofitable for non-irrigators to enter the market.

Table 1. Number of observations and mean of WTP and WTA (€/m^3/ha)*

Scenarios		Volume	Observations	Combined Sample	Guadalquivir Basin	Almanzora Basin
Normal year	WTP	500m^3/ha	52	0.35	0.15	0.39
		1000m^3/ha	53	0.34	0.16	0.39
	WTA	500m^3/ha	79	0.28	0.15	0.41
		1000m^3/ha	80	0.28	0.15	0.40
Drought year	WTP	500m^3/ha	78	0.37	0.17	0.54
		1000m^3/ha	86	0.36	0.16	0.54
	WTA	500m^3/ha	61	0.42	0.17	0.55
		1000m^3/ha	60	0.42	0.17	0.55

***** average values WTP>0 and WTA>0

Source: Own elaboration based on survey

The econometric model allows us to classify farmers according their stated intention towards water trading:

- The participative farmer, with higher activity on water market, namely with a willingness of buying and selling. The major likelihood of being in this class has been found among farmers with agricultural training, who make frequent improvements and where the guarantee of the water supply is insufficient although holds adequate information on annual water allocation. In general, farmer's participation is not

contingent upon crops pattern. Most of them grown intensive olive in Guadalquivir while vegetables crops in Almanzora basin (Almeria).

- On the other side, there are farmers reticent to participate in water market and, they have lower degree of innovation, higher guarantee of water supply, growing extensive arable crops or traditional olive tree.

Afterward, farmers' monetary values for buying and selling water allocations are analysed, estimating a two-steps Heckman's model. As expected, the values for WTP and WTA prices are highly influenced by the fee that irrigators currently pay for the water and also by the productive orientation, being higher for high value crops with lower water-deficit resistance, namely vegetables and citrus, while being lower for olive crop, which are water-deficit tolerant crops. However, exception has been found for intensive olive crop showing in Guadalquivir higher WTP values. In a drought scenario there are more factors explaining the values of WTP and WTA prices, as presence of private reservoir, no farming training or on-farm family labour dependency.

4. Concluding remarks

Water trade is being increasingly adopted in water stressed regions (Southwest USA, Canada, Chile, Australia, South Africa, and Spain) as an instrument to deal with scarcity and reducing droughts impact. This research has tried to gain knowledge on factors that influence the acceptance of water trade and the results should be taken into consideration for water management and policy in the case that policy makers decide implementing water trade for irrigation water management.

According to the findings, an increase of farmer's participation is related to their innovativeness, to the fact of having a formal agricultural training, and to farms with high value crops. Additionally, low supply security and appropriate information on seasonal water availability are also related to a higher probability of participation.

For policy makers, our result indicates that more transparency and timely disclosure about water supply as well as better information on water market may increase farmer's participation and therefore improve water allocation efficiency in the basin, which in turn might reduce economic losses under drought conditions.

5. Reference Section

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