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The impact of the water rights system on smallholder irrigators' willingness to pay for water in Limpopo province, South Africa

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ABSTRACT. Water rights are currently receiving increased attention from scholars and policymakers due to the growing understanding that ill-defined water rights impair efficient use. In South Africa, smallholder irrigation faces problems of low water use efficiency and cost recovery of government investments. This study uses contingent ranking to analyse the willingness to pay (WTP) of smallholder irrigators for changes in the water rights system. The results indicate that smallholders are prepared to pay considerably higher water prices if these are connected to improvements in the water rights system. By segmenting the population it was also shown that the importance attached to water rights dimensions varies in each segment. While lower institutional trust and lower income levels lead to a lower WTP for transferability, experiencing water

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shortage increases this WTP. Such information is valuable in guiding policy makers in the future design of water rights.

1. Introduction

Internationally there is growing understanding that water rights are important and that a lack of effective water rights systems creates major problems for the management of increasingly scarce water supplies (Matthews, 2004; Bruns *et al*., 2005; Meinzen-Dick and Nkonya, 2005). This is because, in general, ill-defined property rights limit the value people assign to a resource (Randall, 1978; Ostrom, 2000; Heltberg, 2002; Linde-Rahr, 2008; Halsema and Withagen, 2008; Libecap, 2009). Ill-defined water rights create high transaction costs (information search, negotiation, monitoring) for making decisions over water use, which seriously impairs the efficient use of water (Challen, 2000; Wichelns, 2004). This implies that if water rights are better defined, people will be willing to pay higher prices for water use because the transaction costs will be reduced (Herrera *et al*, 2004). This makes it possible to use contingent valuation methods to evaluate alternative water rights policy options (see for example Herrera *et al*., 2004 or Frija *et al*., 2008).

According to McCann *et al*. (2005), choice experiments are particularly promising tools for such analysis because of their potential to separately value different characteristics of a given situation. This study focuses on smallholder irrigators in South Africa and uses contingent ranking (CR), a form of choice experiment, to evaluate potential improvements in the country's water rights system. This study has policy relevance as, since its introduction in 1998, South Africa's water rights system has been the subject of extensive criticism (see Louw and van Schalkwyk, 2002; Nieuwoudt, 2002; Perret, 2002; Nieuwoudt and Armitage, 2004; Backeberg, 2006; Pott *et al*., 2009). Also smallholder irrigation schemes[1] play a potentially important role in rural development. Improved water rights can not only stimulate smallholders to use water more productively and invest in water conserving technologies (Wichelns, 2004; Bruns, 2003, 2007; Brooks and Harris, 2008), but their resulting higher willingness to pay (WTP) for water can also allow governments to improve cost recovery (Ntengwe, 2004; Virjee and Gaskin, 2005). Both these aspects are of relevance as the smallholder irrigation sector in South Africa is inefficient in its use of water (Speelman *et al*., 2008a) and the level of cost recovery of government investments is considered insufficient (Backeberg, 2006; Perret and Geyser, 2007).

A second aim of this study was to evaluate the effect of different population characteristics on people's WTP. This additional information can help policy makers to better target their interventions, by improving their knowledge about likely support among different types of farmers

[1] Smallholder irrigation schemes in South Africa are areas in the former homelands or in other resource poor areas equipped for irrigation by the state or by previously disadvantaged farmers and development agencies. The typical farmer usually has around 1.5 ha of land, while the total size of the schemes can range from 5 to more than 1,000 ha (Denison and Manona, 2009).

for specific interventions. In this way the impact of the water right improvements can be increased.

2. Methodology

This study developed a CR experiment to determine WTP for improvements in the water rights system. CR is a survey-based technique for modelling preferences for goods, where goods are described in terms of their attributes and the level these take. Respondents are presented with various descriptions of a good, differentiated by their attribute levels and asked to rank the various alternatives. The technique originates from marketing and transportation science but more recently choice models, of which CR is a special form, have proven to be useful in valuing other multidimensional interventions (Hanley *et al.*, 2001, Bateman *et al.*, 2006; Burton *et al.*, 2007; Kanyoka *et al.*, 2008; Mondelaers *et al.*, 2009; Do and Bennett, 2009). Like other choice models, CR avoids an explicit elicitation of respondents' willingness to pay. CR however provides more information than classical choice models, because its rankings show more about the preferences of the respondents (Holmes and Adamowicz, 2002).

There are some potential problems in using the method: these include the complex nature of the statistical design, the selection of the appropriate attributes and levels and the cognitive difficulties that participants may experience when ranking choices (Hanley *et al.*, 2001). Typically, the design of a choice experiment involves three stages (Bennett and Adamowicz, 2001; Holmes and Adamowicz, 2002). Firstly, the problem has to be characterised. Then the attributes and their levels should be chosen. Finally, experimental design procedures are used to construct the ranking tasks that will be presented to the respondents. The following paragraphs discuss the implementation of these steps in this study.

2.1. Characterisation of the problem

The National Water Act (Republic of South Africa, 1998) replaced the previous system of water rights and entitlements, which was based on the ownership of riparian land, with a new system of licences. These licenses are administrative, valid for limited period and come under conditional authorizations in case of using water (Nieuwoudt, 2002). Except for the fundamental right of access to water for basic human needs, all other water uses require a licence (Stein, 2005). This change must be seen in the context of the efforts made by the new democratic government since 1994 to overcome the legacy of the apartheid system by restructuring the constitution, legal system, policies and administration (Wester *et al.*, 2003). The issuing of licences to existing and potential new water users is an ongoing process and licences have been introduced gradually in different parts of the country depending on the degree of water scarcity (DWAF, 2004).

Several authors have already identified shortcomings in the new water rights system. Backeberg (2006) describes how the short review period (every five years) of licenses has a negative effect on farmers' investment decisions. This review period was adopted to allow government to take timely measures to maintain the integrity of water resources, achieve a balance between water supply and demand or accommodate changes in water use priorities (DWAF, 2004). However, the conditions attached to licences can be changed at each review (for instance, the volume and timing of abstractions, or the volume that may be stored) and this gives farmers the impression that their licences are insecure (Nieuwoudt and Armitage, 2004). The same authors also point out that the allocation is not entirely reliable because there is no guaranteed supply; although the licence specifies the quantities that can be abstracted, there is no guarantee that there will be a sufficient supply to do so (Republic of South Africa, 1998; Pott *et al.*, 2009). This has a negative effect on the quality of the title because the capacity of the title to adequately describe the resource is limited. Finally, Louw and Van Schalkwyk (2002) have criticized the provisions for transferability. Transferable water rights and water markets are generally believed to improve water productivity by allowing the transfer of water rights from low-value users to high-value users (Bjornlund and McKay, 2002; Nieuwoudt and Armitage, 2004; Bruns and Meinzen-Dick, 2005; Zekri and Easter, 2007; Brooks and Harris, 2008), although over-regulation will reduce the efficiency gains (Rosegrant *et al.*, 1995; Shi, 2006).

In South Africa water right transfers, which constitute a trade in water use authorizations, are subject to the same requirements as license applications and the water management agency has to approve every transfer. This type of administrative procedure seems to create unnecessary transaction costs for transfers of water rights among irrigators in the same irrigation scheme, limiting any efficiency gains from such transfers (Pott *et al.*, 2009). In addition, the legislation is vague about these arrangements and the conditions under which trade will be permitted (Perret, 2002; Backeberg, 2006). Unless the National Water Act is amended, the practice of trading will have to further develop within the framework of common law (Pott *et al.*, 2009).

2.2. Design of the attribute space

One useful way of analysing rights to natural resources categorizes six dimensions: duration, exclusivity, quality of title, flexibility, transferability and divisibility of rights[2] (FAO, 2001; Bruns, 2006). This categorization highlights how the attributes of rights can be adjusted separately along various dimensions, specifying rights, while implicitly leaving other attributes of rights undefined. Challen (2000) and Crase and Dollery (2006) have shown how this classification can be applied to water rights. To keep our analysis within manageable proportions we choose to apply only the dimensions that are most relevant to the present situation in South Africa. These were chosen from a literature review (Louw and van Schalkwyk, 2002; Nieuwoudt, 2002; Perret, 2002; Nieuwoudt and Armitage,

[2] Duration is used to represent the period of the rights. Exclusivity describes the extent to which others can be prevented from accessing the item/resource or enjoying the benefits that flow from it. The transferability dimension encapsulates the ease with which a right may be passed to others. Divisibility depicts the degree to which the right can be subdivided, and flexibility defines the extent to which the right permits an alteration to the pattern of use. Finally, the quality of title attribute encompasses the capacity of the title to adequately describe the resource or item (Crase and Dollery, 2006).

Table 1. *Attributes and levels used in the choice sets*

Attributes	*Levels*		
Transferability	Not transferable[a]	Agency-based transfer	Market transfer
Duration	5 year[a]	10 year	
Quality of title	Guaranteed quantity	Quantity not guaranteed[a]	
Price	0.06 R/m^{3}[a]	0.09 R/m^3	0.12 R/m^3

[a]indicates the base level.

2004; Backeberg, 2006), which identified duration, transferability and the quality of the title as the dimensions that were attracting the most concern. The selected attributes and levels were also discussed with sector experts from the Department of Water Affairs and Forestry and the Water Research Commission. Table 1 provides an overview of the attributes and attribute levels considered.

The National Water Resources Strategy Paper of South Africa (DWAF, 2004) stipulates that a water license should be re-evaluated at least every 5 years. The base level for the duration attribute was therefore set at 5 years. A second alternative duration of 10 years was chosen: this is considered long enough not to deter most investments, while still allowing government to respond to changing circumstances. Three levels of transferability were introduced in the CR experiment: no possibility to transfer, agency-based transfer and market transfer. As explained in section 2.1, the agency-based transfer option fits best with the current legal provisions. However, because non-transferable water rights reflect the current situation on the ground and because of the legal uncertainty regarding transferability, it was considered relevant to include the option of non-transferable water rights. The dimension of quality of title covers the adequacy of the title in describing the resource or item. Two levels of this dimension, non-guaranteed and guaranteed supply, were chosen for this study. Finally, to be able to economically value attribute changes, a pricing vehicle was included. We used the unit price of water in rand (R), (R/m^3), to evaluate respondent's WTP for changes in the different attributes. The price attribute was set at three levels: 0.06, 0.09 and 0.12 R/m^3.[3] The price of 0.06 R/m^3 corresponds to typical water prices for irrigation in the study area (DWAF, 2008a, b).

2.3. *Design of the ranking sets*

The full factorial design or all possible combinations of four attributes, two with two different levels and two with three different levels, provide 36 possible water right definitions. Clearly, it would not be feasible to ask respondents to rank 36 profiles. Consequently, it was necessary to reduce the number of profiles by grouping them into smaller sets of four (Bennett and Adamowicz, 2001; Alriksson and Öberg, 2008). This was done in three stages. In the first stage we constructed an orthogonal design, using the

[3] The average exchange rate at the time of data collection was 1R = 0.13US$.

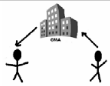
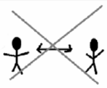
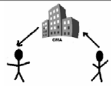
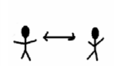
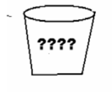
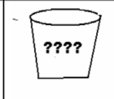
Attributes	Option 1	Option 2	Option 3	Option 4
Transferability[a]				
Duration	5 years	10 years	10 years	5 years
Quality of title[b]				
Price	12 c/m³	6 c/m³	9 c/m³	12 c/m³

Figure 1. *Choice set example.*
Notes: [a]Icons for the transferability attribute refer to the 'agency-based transfer', 'no transfer', 'agency-based transfer' and 'market transfer' respectively. [b]Icons for quality of the title attribute refer to 'guaranteed quantity', 'guaranteed quantity', 'quantity not guaranteed' and 'quantity not guaranteed' respectively.

Orthoplan-function in the statistical package SPSS. The construction of the orthogonal design provided nine profiles. Then we used a design procedure developed by Street *et al.* (2005) to create nine sets of 4 profiles. The interested reader can consult their work for more information about the procedure.

Street *et al.* (2005) demonstrated that choice sets constructed in this way are balanced and minimize attribute-level overlap, which allows more information to be collected from the same sample size. These properties mean that the technique will always yield the optimal or near-optimal design for estimating main effects and the near-optimal design for estimating main effects plus two-factor interaction effects. This can be demonstrated using the Fisher information matrix.

In the final stage, following Holmes and Adamowicz (2002), it was decided to randomly divide the choice sets into blocks to avoid 'respondent fatigue'. Each respondent would be randomly assigned to a particular block. Three blocks of three choice sets were constructed. Figure 1 presents a choice set. The attributes were graphically represented because it was expected that part of the respondent population would be illiterate. Farmers are currently operating under a 'base scenario' definition of water rights, which has the lowest water price. Because this study is concerned with improvements to this base scenario, we did not include a classic 'no choice' option in the choice sets. This is also seen elsewhere in the literature (Blamey *et al.*, 1999; Foster and Mourato, 2002; Bateman *et al.*, 2006; Hanley *et al.*, 2006). If such an option were to be included in the choice set, by construction one of the other options would always be dominant, because each choice contains at least one option where price remains at the low level and one or more of the other attributes are improved.

2.4. Data collection

The data were collected in April 2008 in the Limpopo province of South Africa (see figure 2). A sample of eight irrigation schemes that typified

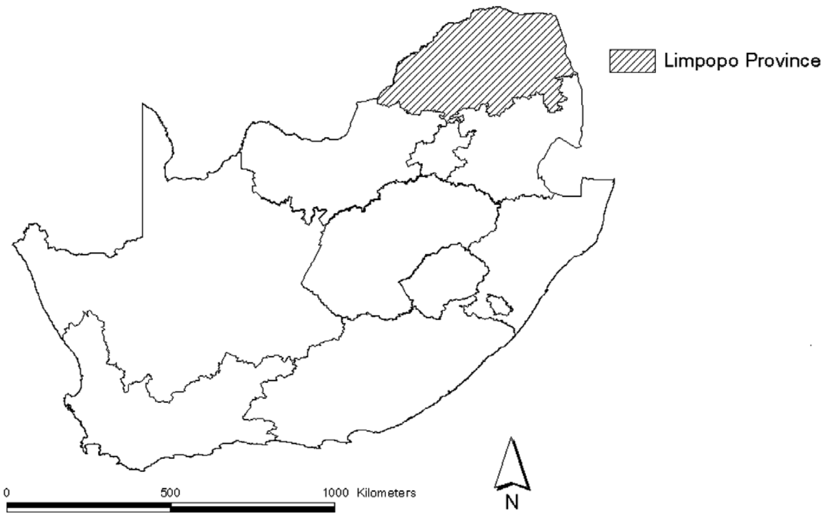


Figure 2. *Location of Limpopo province within South Africa.*

smallholder irrigation schemes in rural South Africa was identified from the national database of small-scale irrigation schemes. This sample included both larger irrigation schemes, with more than 100 farmers, and smaller schemes, with 30–40 farmers. The total area covered by the schemes was about 1,000 ha. Care was taken that the sample covered different cropping patterns which, in turn, reflect varying degrees of water scarcity.

Contacts with the scheme managers were made through the agricultural extension services[4] responsible for the schemes. About 30% of the farmers in these schemes were randomly selected from a list of active farmers provided by the scheme management. A team of interviewers consisting of post-graduate students from Limpopo University in Polokwane was trained to conduct the interviews. The training also involved one day of pre-testing the questionnaire. The farmers were interviewed in their fields. Before starting the questionnaire, the interviewers explained the objective of the study and gave information about the existing water rights system. In a stepwise manner, the farmers were familiarised with the graphical representation of the attribute levels in the CR experiment. In addition to the CR experiment the questionnaires also asked for detailed information regarding farming activities, alternative income sources and institutional aspects of water management. On average, the interviews took about 45 min. In total 134 questionnaires were completed, which provided 402 choice sets for analysis.

[4] This is a governmental service providing training and technical advice to farmers. In practice, an extension officer is responsible for providing assistance to the farmers of all the irrigation schemes in his sector.

2.5. Analytical framework

The econometric analysis of data collected from a CR experiment is based on McFadden's conditional logit model, which is grounded in the random utility framework (McFadden, 1974). The indirect utility function U_{ij} is decomposed into two parts:

$$U_{ij} = b(X_{ij}, Z_i) + e_{ij}. \tag{1}$$

The first is an observable element $b(X_{ij}, Z_i)$ which describes the preferences of respondent i as a function of the attributes of the alternatives presented to the individual X_{ij} and the characteristics of the individuals Z_i. The second is a stochastic element e_{ij}, which represents those influences on individual choice that cannot be observed by the researcher.

Typically, it is assumed that the e_{ij} are independently and identically distributed with an extreme value (Weibull) distribution, resulting in a conditional logit model. However, a conditional logit model only allows the identification of the most preferred alternative and thus does not fully utilize all the information contained in a CR experiment. Beggs *et al.* (1981) developed an extension to the basic conditional logit model, known as the rank-ordered logit model. This is capable not only of identifying the most preferred alternative but also the exact ordinal ranking of all the remaining elements. In the model, the probability of obtaining a particular ranking can be expressed as (Hanemann and Kanninen, 1999)

$$P(U_{i1} > U_{i2} \ldots > U_{ij}) = \prod_{j=1}^{J} \frac{\exp(b\,X_{ij})}{\sum_{k=j}^{J} \exp(b\,X_{ik})}. \tag{2}$$

Once the parameter estimates of this model have been obtained, a WTP can be derived for each attribute (Hanley *et al.*, 1998, 2001). When it is assumed that utility is a linear function of the attribute levels, as in (1), WTP can simply be expressed as

$$WTP = \frac{-b_c}{b_y}, \tag{3}$$

in which b_y is the coefficient of the cost attribute and b_c is the coefficient of any of the other attributes. Equation (3) therefore expresses the marginal rate of substitution between the price attribute and the other attribute in the equation and provides what is technically known as the implicit price.

3. Results and discussion

3.1. Characteristics of the sample population

Some selected characteristics of the sample population are presented in table 2. The average age of the farmers in the sample was 58 years, they had an average of 5.6 years of schooling and the average plot size was 1.2 ha. These figures are typical for this population as a whole (Perret, 2002; Van Averbeke and Mohammed, 2006; Hope *et al.*, 2008). The schemes in the sample are surface irrigated, which is the prevailing method on South African smallholder schemes. In the drier regions of Limpopo most farmers

Table 2. *Selected sample population characteristics*

	Mean (standard deviation)	*Range*
Farmers' age (years)	57.8 (13.2)	27–85
Adult education (years)	5.6 (4.5)	0–15
Irrigated plot size (ha)	1.2 (0.4)	0.4–4
Income share from irrigation (%)	29 (24)	1–100
Commercialisation (%)	38 (30)	0–100

only cultivate the irrigated land during the wet summer season, and maize is the most important crop. In other parts of the province production is more diversified: the majority of the farmers produce maize in summer and a wide variety of crops in winter. Spinach, beans, beetroots, cabbages and tomatoes were the most important winter crops among this sample.

For most of the households in the sample, cropping is not their main source of income. As in most rural areas of South Africa, pensions and child allowances are the most important income sources (Perret *et al.*, 2003; Hope *et al.*, 2008). The income share from irrigated farming among the farmers was highly variable, ranging between 1% and 100% with an average of 29%. Higher dependency on income from irrigated farming was generally associated with a lower overall income level, as it generally reflected an absence of other income sources. Most production is subsistence-oriented. The average degree of commercialisation, calculated as the value share of production that is marketed, was 38%.

From the survey it is apparent that water shortages at irrigation schemes in Limpopo province mainly manifest themselves in reductions in the area cultivated during the dry season. In the winter season, 37% of the farmers reduce their cultivated area and about the same proportion of farmers stop production. This study also monitored respondents' level of trust in water management institutions. Farmers were asked to indicate on a 5 point Likert scale how much confidence they had in three different levels of water institutions. These scores were then averaged. Nearly 36% of the farmers had low confidence in the functioning of the water management institutions (average score of less than 1.7), 31% claimed to have a lot of confidence (average score of more than 3.3), and trust levels for the remaining 34% were somewhere in between.

3.2. Rank-ordered logit results

The results of the rank-ordered logit models were obtained using the statistical package STATA version 9. Following the recommendations of Holmes and Adamowicz (2002), qualitative attributes were effect-coded. When using effect-coding, the base level is assigned code −1. For the quality of title dimension, 'non-guaranteed supply' was the base level while for the transferability, the base level was 'no possibility to transfer'. In effect-coding the utility of the base level of a variable equals the negative of the sum of the coefficients for the other levels of that variable, while the utility of the other levels corresponds to their coefficient. A Hausman specification test

Table 3. *Rank-ordered logit model results (full sample n = 134)*

Attributes	*Coefficient (standard errors)*	*Odds ratios*	*% change in odds*
Duration	0.096[a] (0.014)	1.100	10
Quality of title	0.628[a] (0.038)	1.875	87.5
Agency-based transfer	0.230[a] (0.050)	1.259	25.9
Market transfer	0.360[a] (0.051)	1.433	43.3
Price	−0.048[a] (0.015)	0.953	−4.7
Model Fit[b]			
Pseudo R^2	0.177		
Likelihood ratio (LR)	452.217[a]		

[a]significant at 0.01.
[b]The Pseudo R^2 reported here and in the following tables is also known as Mc Fadden rho square.

was performed for all models to test the assumption of independence of irrelevant alternatives (IIA), a specific assumption, which always has to be tested for this type of models. The data supported this assumption for all models. Table 3 presents the rank-ordered logit estimates for the full sample. Interaction effects were tested, but none of them were retained in the model as their coefficients were not significant.

All the coefficients in the main effects model significantly differ from zero at a 99% significance level, meaning that they all are significant determinants of choice. The signs of the attribute parameters are as expected. Guarantee of water supply, increased duration of the licence, and improvements in transferability all increased the probability of an option being chosen. Conversely, a higher water price decreased this probability. This is also reflected in the odds ratios and the derived percentage change in odds, which reflect the difference in probability of choosing a particular option when the attribute changes. For most respondents, guaranteed supply and market transfer were most important.

In a second step the population was stratified in three ways: first according to the level of water shortage experienced by the farmers, second according to the overall income share derived from irrigated production, and finally according to their level of trust in the water management institutions. The model's results for these different segments of the population are presented in tables 4–6.

Likelihood ratio tests confirmed that the parameter estimates are not identical for the different segments. Table 4 compares results for respondents who experienced severe water shortages (and reduced the area they cultivate in the dry season by more than 25%) and respondents who did not experience water shortages (no reduction in cultivated area). Results for the remaining group of farmers are not reported because the sample ($n = 16$) was too small to yield reliable results. The probability of choosing a water right option with an assured water supply was clearly much higher among farmers experiencing water shortages than those who do not experience shortages. In addition farmers experiencing shortages

Table 4. *Rank-ordered logit model results for segments with different levels of water shortage*

	No water shortage (n = 36)			*Water shortage (n = 82)*		
Attributes	*Coefficient (standard errors)*	*Odds ratio*	*% change odds*	*Coefficient (standard errors)*	*Odds ratio*	*% change odds*
Duration	0.093[a] (0.026)	1.097	9.7	0.092[a] (0.018)	1.097	9.7
Quality of title	0.499[a] (0.070)	1.647	64.7	0.672[a] (0.050)	1.959	95.9
Agency-based transfer	0.301[a] (0.095)	1.352	35.2	0.247[a] (0.064)	1.280	28.0
Market-based transfer	0.210[b] (0.095)	1.233	23.3	0.471[a] (0.067)	1.602	60.2
Price	−0.054[b] (0.028)	0.947	−5.3	−0.052[a] (0.019)	0.950	−5.0
Model fit						
Pseudo R^2	0.136			0.202		
LR	93.324[a]			315.950[a]		

[a]significant at 0.01; [b]significant at 0.05.

show a stronger preference for market transfer, probably because they see this as a potential way of ensuring access to water supply (Pott *et al.*, 2009). Bjornlund (2006), Calatrava and Garrido (2005) and Hadjigeorgalis (2008) have also described the role that water markets could play in addressing supply risk in regions with fluctuating supply.

Table 5 illustrates the importance of institutional trust. For farmers with low institutional trust mainly the quality of the title is important, while introduction of agency-based transfer hardly increases the odds. Farmers with a high level of institutional trust consider a system with agency-based transfer to be as important as the quality of the title. Thus, any change in the transferability of water rights would appear to first require an improvement in the levels of trust in the water institutions to be successful. As long as levels of trust are low, people will not value increased transferability and therefore improvements in efficiency or cost recovery will not be fully exploited. Communication is an important aspect here; at present farmers have a low awareness about how the water management institutions work and what their responsibilities are. This issue was also raised in earlier studies by Wester *et al.* (2003), Waalewijn *et al.* (2005) and Orne-Gliemann (2008). The smallholders' unfamiliarity with the water management institutions might explain their current low level of trust in these institutions.

Table 6 shows the impact of the income contribution of irrigation on the preferences of farmers. It compares farmers for whom irrigation makes a small income contribution (<20%) with those for whom it makes a high contribution (>35%). If the income from irrigation constitutes only a small part of the total family income, then a unit price increase only has a minor impact on the odds of choosing an option. When irrigation is responsible for 35% or more of the family income, the disutility of a unit price increase

Table 5. *Rank-ordered logit model results for segments with different institutional trust levels*

	Low trust (n = 48)			*Medium trust (n = 45)*			*High trust (n = 41)*		
Attributes	*Coefficient (standard errors)*	*Odds ratio*	*% change odds*	*Coefficient (standard errors)*	*Odds ratio*	*% change odds*	*Coefficient (standard errors)*	*Odds ratio*	*% change odds*
Duration	0.093[a] (0.023)	1.098	9.8	0.088[a] (0.023)	1.087	8.7	0.105[a] (0.025)	1.110	11
Quality	0.798[a] (0.069)	2.221	122.1	0.628[a] (0.065)	1.875	87.5	0.479[a] (0.068)	1.615	61.5
Agency-based transfer	0.046 (0.084)	1.047	4.7	0.236[a] (0.087)	1.267	26.7	0.481[a] (0.092)	1.618	61.8
Market-based transfer	0.252[a] (0.089)	1.286	28.7	0.392[a] (0.086)	1.480	48.0	0.458[a] (0.097)	1.581	58.0
Price	−0.084[a] (0.025)	0.920	−8	−0.028 (0.026)	0.973	−2.7	−0.028 (0.027)	0.972	−2.8
Model fit									
Pseudo R^2	0.210			0.186			0.190		
LR	192.610[a]			159.355[a]			148.406[a]		

[a]significant at 0.01.

Table 6. *Rank-ordered logit model results for segments with different reliance on irrigation for their income*

Attributes	*Low-income contribution (n = 63)* Coefficient (standard errors)	Odds ratio	% change odds	*High-income contribution (n = 40)* Coefficient (standard errors)	Odds ratio	% change odds
Duration	0.116[a] (0.020)	1.123	12.3	0.094[a] (0.025)	1.098	9.8
Quality of title	0.575[a] (0.055)	1.778	77.8	0.793[a] (0.076)	2.210	121
Agency-based transfer	0.172[a] (0.072)	1.188	18.8	0.201[b] (0.093)	1.223	22.3
Market transfer	0.410[a] (0.076)	1.507	50.7	0.355[a] (0.099)	1.426	42.6
Price	−0.036[c] (0.022)	0.965	−3.5	−0.121[a] (0.028)	0.886	−11.4
Model fit						
Pseudo R^2	0.165			0.237		
LR	198.682[a]			180.929[a]		

[a]significant at 0.01; [b]significant at 0.05; [c]significant at the 0.1.

is about three times larger. As all the farmers in the sample have similar sized plots, a larger income share from irrigation is usually associated with a lower and less diversified total income. This could clearly be seen in the dataset and is in accordance with findings for other smallholder schemes (see Perret *et al.*, 2003; Yokwe, 2009). For farmers who are more financially dependent on irrigation, the quality of the title is much more important since their income is more affected by insufficient supply.

One of the main objectives of this study was to obtain the implicit values of marginal attribute changes. Figure 3, based on (3), presents the estimates of the implicit prices derived for the entire sample and for different strata. The results for the full sample indicate that the average farmer highly values securing supply (WTP of 0.12 R/m^3) and the opportunity for agency-based transfer (WTP of 0.14 R/m^3 for a shift from not transferable to agency-based transfer). Compared to a system of agency-based transfer, the establishment of water markets does not seem to add much value, yielding an additional WTP of just 0.02 R/m^2.

The impact of smallholder characteristics on their WTP can be assessed by comparing the WTP for different segments of the sample. This analysis shows that respondents in the different segments have quite different WTP for the attribute changes. Farmers experiencing water shortages are willing to pay more for a secure supply than those not experiencing shortages (0.13 R/m^3 compared to 0.09 R/m^3) and also to pay more for improved transferability of water rights. Figure 3 shows that this applies to both transferability levels (agency- and market-based). This finding could, again, be taken as indicative that these farmers see transferability as an option for assuring a secure water supply in periods of drought. It is evident that the WTP of farmers with low levels of institutional trust is lower for all attribute changes than for those with medium or high institutional trust. The difference is particularly marked when evaluating a change from no

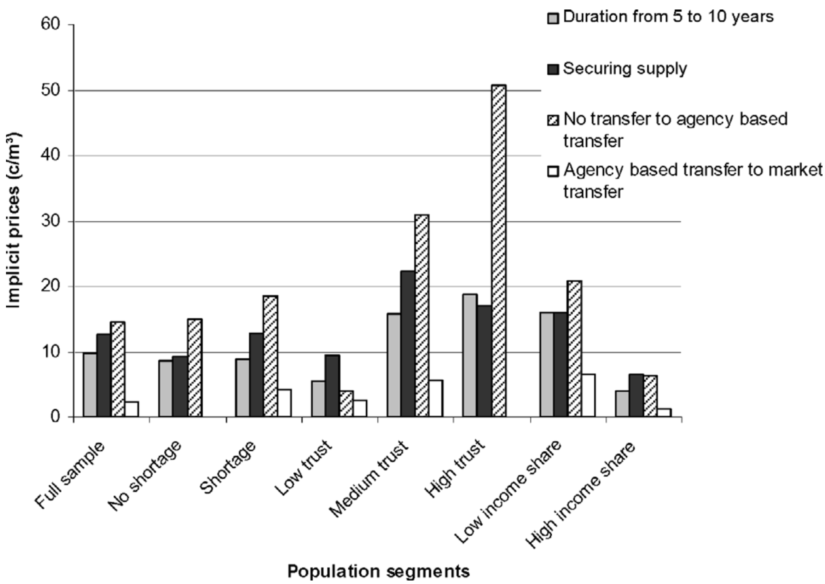


Figure 3. *Implicit values of attributes changes for different segments.*

transfer to agency-based transfer, an option for which farmers with low institutional trust are only willing to pay 0.04 R/m^3, compared to 0.31 R/m^3 and 0.50 R/m^3 for those with medium and high trust, respectively. It is also of interest that when institutional trust is high, agency-based transfer is preferred to market transfer (very small negative WTP to go from agency-based transfer to market transfer).

Overall the analysis makes it clear that trust in institutions is a very important determining factor when it comes to evaluating property rights. Another finding is that the WTP of poorer farmers (who depend more on irrigation) is lower for all attribute changes. This may well reflect the limited capacity of these poorer farmers to pay for water, a problem already identified by Backeberg (2006) and Perret and Geyser (2007). This implies that pursuit of the cost recovery objective needs also to pay close attention to increasing the productivity and thus the income of these farmers.

4. Conclusions

As competition for water grows and supplies come under more strain, water users and water management organizations are seeking better institutional arrangements for coordinating use and resolving conflicts. Improving water rights is one option for increasing water productivity, increasing the benefits from existing and new investments in water supplies, and enhancing rural livelihoods. In this way improvements in water rights can help to reduce poverty (Meinzen-Dick and Nkonya, 2005).

This study demonstrates how CR can be used to measure the benefits from improving different dimensions of water rights among smallholder irrigators in South Africa. While such farmers have a potential to contribute to poverty reduction in rural areas, they clearly struggle with problems of low water use efficiency and insufficient cost recovery of government investments (Speelman *et al.*, 2008b). In this context it is pertinent to evaluate the expected impact of water rights reforms on this stakeholder group.

The results of the rank-ordered logit model using the full sample indicate that improved water rights can bring significant economic benefits to smallholders. They highly value the possibility to transfer such rights and receive an assured supply. However these overall results mask large differences between different segments of the farming population. Farmers experiencing water shortage have a higher WTP for a secure supply and for improved transferability of water rights. As indicated by Pott *et al.* (2009), these farmers see improvements in the water rights system as a potential solution for their water shortage problem. Calatrava and Garrido (2005) studied an irrigation district in Southern Spain, under similar climatic conditions, and demonstrated that water markets can play an important role in countering supply risks.

Our analysis of institutional trust indicates that trust in the institutions is necessary to fully value water rights improvements. This implies that, from a cost recovery perspective, it is important for the government to increase the level of trust of small-scale farmers in the water management institutions, since this will increase their WTP for the proposed interventions in the water rights.

Finally, the poorer farmers in the sample, who are more dependent on irrigation for their income, experience a significantly stronger disutility of water price increases, which limits their WTP for water rights improvements. This again highlights the importance of continuing effort from government departments and the research community to help smallholder irrigators in South Africa to increase their productivity and income (Backeberg, 2006).

While the results presented in this paper offer valuable insights to policy makers to guide water right reforms, the approach also has its limitations. The type of analysis provided here should be part of a broader framework that also weighs the costs of the interventions against the benefits. Some reforms, such as an increase in the licence review period, might lower costs, while others will have a price tag attached to them. Furthermore, in a country such as South Africa where equity is a prime concern, it is important to consider the distributional effects on all stakeholders. Intersectoral water markets for example might cause water re-allocation from agriculture to non-agricultural uses, with negative effects for smallholder irrigators. Further research is required to add to our knowledge of what the effect of water rights interventions is on different stakeholders and the costs of these interventions.

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