Comparing the scope for irrigation water rights reforms in India and South Africa

Speelman Stijn[*], Veettil Prakashan Chellatan

Department of Agricultural Economic, Ghent University

***Corresponding author: stijn.speelman@ugent.be**

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Abstract:
In many countries growing water scarcity puts pressure on the irrigation sector, as main consumptive user, to improve performance. In this context, the need for research on institutional policy options for improved water allocation and governance is more and more recognized. Ex-ante evaluation of institutional changes, such as reforms in water rights systems, is however a challenging task. In this article two case studies are considered. Choice modelling is used to evaluate the preferences of irrigators in India and South Africa for different water rights configurations. By comparing the results of both case studies insight is gained on the effects of context specific factors. Both the information from the individual choice experiments as the comparison across cases reveals interesting information for policy makers to guide institutional reforms.

Keywords: Water property rights, irrigation , India, South Africa

1. Introduction

Increasing population growth, economic activity and development pose increasing stress on the world's finite water resources. In the past solutions often were supply oriented and had a technical focus, such as improved irrigation and water supply technology or interbasin transfers to increase supply in water-scarce regions. Currently however, it is clear that water resources management requires an interdisciplinary approach and that sound institutional arrangements are crucial to improve water use efficiency and allocation (Kemper 2001; Brennan, 2002; Bruns et al., 2005). An institutional option, receiving a lot of attention is the improvement of the water rights system (Araral, 2010; Gastélum et al. 2009; Molle, 2004; Bruns et al., 2005; Matthews, 2004; Meinzen- Dick & Nkonya, 2005; Hodgson, 2006). Kemper (2001) even emphasizes this as the most central point in institutional reform to achieve more efficient water use and allocative efficiency.

The theoretical rationale for installing water rights is based on arguments of efficiency, i.e., only when water rights are clearly defined Pareto optimal outcomes are possible (Araral, 2010). A clear definition of who is entitled to use a certain amount of water, with the specification on when and where this is possible, will reduce uncertainty and conflicts (Molle, 2004). In contrast, when property rights are poorly defined, this creates high transaction costs (information search, negotiation, monitoring) and limits the value people assign to a resource (Randall, 1978; Ostrom, 2000; Challen 2000, 2002, Wichelns 2004, Heltberg, 2002; Linde-Rahr, 2008). This confines the incentives for resource users to manage a resource sustainably (Yandle, 2007).

Several authors have identified the need to quantify the degree of efficiency of a prevailing institutional structure or the benefits associated to improving it (Brennan, 2002; Dinar & Saleth, 2005; Linde-Rahr, 2008; Irimie & Essmann, 2009; Araral, 2010). Following the suggestion by McCann *et al*. (2005) we use choice modelling to estimate willingness to pay to reduce policy related transaction costs. These transaction costs can be considered as a measure of the efficiency of a prevailing institutional structure. This paper compares case study data from South Africa and India, highlighting the importance of the water rights system for irrigators. Variants of this approach were recently developed by several authors for the case of water rights (e.g., Crase et al., 2002; Herrera et al., 2004; Frija et al., 2008; Speelman et al., 2010a, 2010b; Veettil et al. 2011a, 2011b).

Furthermore the approach is also closely linked to the work of Barton & Bergland (2010) and Rigby et al. (2010), who use choice experiments to value irrigation water under different institutional settings. The choice to study the potential of water rights reforms specifically in India and South Africa is pertinent because they display some conditions which render water rights configuration more important (Bruns et al., 2005): 1) occurrence of acute water shortages induced by increasing competition and conflict; (2) existence of social inequities in the access to water; (3) presence of severe water stress. On the other hand there are also important differences between the study areas. In South Africa water rights are defined by the 1998 Water Act. They are thus incorporated in national legislation. In contrast India had a variety of water rights systems of various kinds which have existed for a long period of time under various kinds of community-based and state-managed irrigation systems, but no nationwide initiatives were made (Narain, 2009). It will thus be interesting to see if the differences in context have an effect on the valuation of irrigation water rights and on the importance farmers give to them.

2. Importance of irrigation water rights

Institutions such as property rights are seen as a way of structuring human interaction of a repeated nature. They are seen as a way of reducing transaction costs inherent in human exchange. By providing a structure and predictability to human interaction, institutions reduce the inherent transaction costs (North, 2005). From a New Institutional Economics Perspective, property rights in water are seen as an institution that serve as a source of incentives for individual and Group behaviour governing water use. They serve as a mechanism for avoiding externalities in the use of water. They generate incentives for efficient resource use and for avoiding depletion and overexploitation (Narain, 2009). The way property rights are defined will structure the incentives and disincentives which members of society face in their decisions regarding water ownership, use and transfer. Similarly, a well-defined set of rules is necessary to permit market transactions to take place (Qureshi et al., 2009) .

Therefore , clearly defined and secured water rights are important for several reasons. First, they determine if people are included or excluded in the control of a vital resource for their lives. Welldefined and secured water rights can also raise water productivity and can enhance rural livelihoods (Bruns et al., 2005). According to Coase (1960), well-defined property rights internalize the externalities, so that the outcome is efficient regardless of who owns the property rights (Gunchinmaa and Yakubov, 2010). Clearly defined and enforceable water rights are specifically important to developing countries faced with the challenges of better management of water resources. These challenges are likely to increase as a result of increasing urbanization, industrialization, environmental degradation, agricultural intensification and rising per capita water use. As demand for a limited resource increases, tensions and conflicts are likely to arise among various stakeholders in a river basin when water rights are unclear and insecure (Araral, 2010). A clear definition of who is entitled to use a certain amount of water, with the specification on when and where this is possible, will reduce uncertainty and conflicts (Molle, 2004). It will also increase efficiency because without a clear definition of who the users are and how much water they are entitled to, the users themselves have no incentive to use the water efficiently having no guarantee that if they save water today they will receive more tomorrow. (Kemper 2001). Furthermore by giving water users certainty as to what water will be available to them, both over the long term and in any given year provides them with confidence to plan for the future and to invest in waterdependent activities. It also reduces the potential for conflicts, as sharing arrangements are transparent and settled in advance, and provides incentives for more efficient use of resources (Speed, 2009). Finally it is stated by Bruns et al. (2005) that lack of well-defined and unsecure water rights mainly increases the vulnerability of the poor and of politically and economically marginalized water users. Water use rights are thus essential to provide incentives for better water management, but contrary to common belief, there is ample scope to design them in a flexible and locally adapted manner to allow for local needs and circumstances, which may want to take into account individual or common property right cultures, different lengths of validity of the rights, and (non-)transferability (Kemper, 2001).

3. Current water rights systems in South Africa and India

3.1. South Africa

In South Africa, the National Water Act (Republic of South Africa, 1998) replaced the previous system of water rights and entitlements, which had been based on the ownership of riparian land, with a new system of administrative limited-period and conditional authorizations to use water (Nieuwoudt, 2002). This change was part of the efforts of the new democratic government to overcome the legacy of the apartheid system by restructuring the constitution, legal system, policies and administration (Wester et al., 2003). It needs to be noted that this new system only concerns usufruct right, while ownership of the water is held by the state.

Although the new water rights system is currently still not fully operational, several authors have already identified shortcomings. Backeberg (2006) predicted that the short review period for licenses of five years will have a negative effect on farmers' investment decisions. This review period was installed to allow the government to take timely measures to maintain the integrity of the water resource, achieve a balance between available water and water requirements, or accommodate changes in water use priorities (DWAF, 2004). However, that conditions attached to licenses may change at each review (for instance the volumes and timing of abstractions, or the volume that may be stored etc.) gives farmers the impression that licences are insecure (Nieuwoudt & Armitage, 2004). The same authors furthermore point out that the reliability of allocation is impeded because there is no guaranteed supply; although quantities are specified in the license, they are not guaranteed or enforced (Republic of South Africa, 1998). Louw & Van Schalkwyk (2002) criticized the provisions regarding transferability made in the National Water Act. Transferable water rights and water markets are generally believed to improve water productivity through the transfer of water from low value users to high value users (Bjornlund & McKay, 2002; Nieuwoudt & Armitage, 2004; Bruns & Meinzen-Dick, 2005; Zekri & Easter, 2007; Brooks & Harris, 2008) but over-regulation of transfers reduces the efficiency gains (Rosegrant et al., 1995; Shi, 2006; Donohew, 2009). In South Africa, trade in water use authorizations is to be treated in a similar way as new license applications. This means that a water management agency has to approve each transfer. For transfers of water rights between irrigators in the same irrigation scheme, possible externalities of the transfer are limited (Donohew, 2009) and thus the type of administrative procedure proposed appears to create unnecessary transaction costs, limiting efficiency gains from water right transfers.

3.2. India

In India, the Easement Act of 1882 made all rivers and lakes the absolute right of the state. Individual rights to both surface water and groundwater are recognized only indirectly through land rights. Thanks to the 'dominant heritage' principle implied in the Transfer of Property Act IV of 1882 and the Land Acquisition Act of 1894, a land owner can have a right to groundwater as it is considered an easement connected to the land (Saleth, 2004). In the case of canal water, the rights to access are limited only to those having access to land in canal command areas and these rights are only use rights and not ownership rights. In fact, the irrigation acts in all states in India, do not allow the moving of canal water to non canal areas. Thus the water governance and utility services are highly influenced by the public government institutions and in most cases the irrigation services are very poor. While efforts were made to decentralise water governance to the local level by introducing Water User Associations, often in practice the transfer of water rights did not take place. The failure of water rights transfer or creation (including legally binding water rights), adds to the poor performance of the WUAs and irrigation water services._ In the Indian context, current debates on water rights in the context of groundwater revolve around addressing the incentive problem associated with overexploitation, the functioning and regulation of water markets and addressing equity issues, both at the intra-generational as well as inter-generational level. In surface water, too, rights in water have been tied to rights in landholdings, and the need to separate the two has been considered necessary from an equity perspective (Narain, 2009).

4. METHODOLOGY

4.1 Choice experiment design

As mentioned in the previous section, to analyze the water rights system in South Africa and in India, choice experiments were developed (see Speelman et al., 2010a; Veettil et al., 2011b). The technique, which originates from marketing and transportation science, has proven to be useful in valuing multi-dimensional interventions in a system (Hanley et al., 2001, Bateman et al., 2006; Burton et al., 2007; Rigby et al., 2010). Choice experiment are 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 enables both entire interventions and their individual components to be valued. In this way, willingness to pay for improvements in the water rights system can be determined. An advantage of choice experiments is that they avoids an explicit elicitation of the respondents' willingness to pay but rely instead on the ranking of (South African Study) or choice from (Indian Study) a series of alternative packages of characteristics. This has proven to be a more reliable way of eliciting willingness-to-pay values (Foster & Mourato, 2002; Bateman et al., 2006).

A first step in designing a choice experiment is defining the attribute space. In this context it means determining which aspects of water rights will be considered. An influential approach to analyze rights to natural resources categorizes six dimensions: duration, exclusivity, quality of title, flexibility, transferability and divisibility of rights (Scott, 1989). Such subdivision highlights how attributes of rights may be adjusted separately along various dimensions, specifying rights (and implicitly leaving other attributes of rights undefined). According to Yandle (2007), these dimensions can be used to assess the quality of the property right. It was shown by Challen (2000), Bruns (2006) and Crase and Dollery (2006) and Shiferaw (2009), that this deconstruction is also appropriate for water rights. In our case studies the definition of Crase and Dollery (2006) for the six dimensions is used: 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. From these six dimensions only the most relevant are included in the CE in order to keep the size of experiment within manageable proportions. Selection was based on literature review and expert knowledge. Both in South Africa and India duration, transferability and quality of title were selected. As described in section 3.1 , in South Africa criticisms were formulated on one or several of these dimensions by amongst others Perret, 2002; Nieuwoudt, 2002; Louw and Van Schalkwyk, 2002; Nieuwoudt and Armitage, 2004; Gillit et al., 2005; Backeberg, 2006; Pott et al., 2009. In India focus group discussion revealed the most important dimensions for the case study area. Duration was considered important in both countries because for rights holders to have the incentive to use a resource sustainably, they must be confident on the time period over which their rights to the resource will not be diminished (Backeberg, 2006; Yandle, 2007). Transferability is 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). But the way transferability is regulated influence the potential gains with over-regulation reducing the efficiency gains (Rosegrant et al., 1995; Shi, 2006). The quality of the title dimension, finally impacts on the reliability of the water allocations (Nieuwoudt and Armitage, 2004). Finally, to be able to economically value attribute changes, a pricing vehicle was also included in both case studies. In the Indian case study it was furthermore also considered relevant to explicitly incorporate water pricing methods in the choice experiment next to the three water right dimensions. This because unlike in South Africa, where the choice for volumetric pricing and the creation of water users associations is clearly made, there still is much debate on these issues in India (Saleth, 2004; Narain, 2009). In addition, it is expected that complementary relationships exist between the various institutional reforms.

Specification of the attributes space of a choice experiment also comprises the stipulation of the attribute levels used in the experiment. In South Africa for duration, two levels (5 years and 10 years) were included. For transferability the levels considered were no transfer; agency based transfer and market transfer, and for quality of the title, two levels were used in this study: no guaranteed supply and guaranteed supply. Three water price levels: 0.06, 0.09 and 0.12 R/m^3. In the Indian case study, two levels of duration have been selected: short and long duration. Under short duration, water rights are limited to one or only a few crop seasons (< 2 years), whereas in long duration, the water entitlement is for more crop seasons (up to 5-10 years). For the quality of the title the same two levels as in South Africa were used. The t*ransferability* included four levels: No transfers, transfers within WUA, transfers between WUAs and transfers via a water market. In terms of water pricing methods, four water pricing methods were selected. These include area pricing (AP), crop pricing (CP), volumetric pricing (VP) and block pricing (BP). As pricing attribute, four price levels are considered under each pricing method depending on the water demand and types of crops cultivated. These levels are derived from existing water use level, agronomic considerations, cropping pattern and water availability of the region. Finally, the local water governance indicates the presence or absence of collective irrigation water management institutions at the local or regional level.

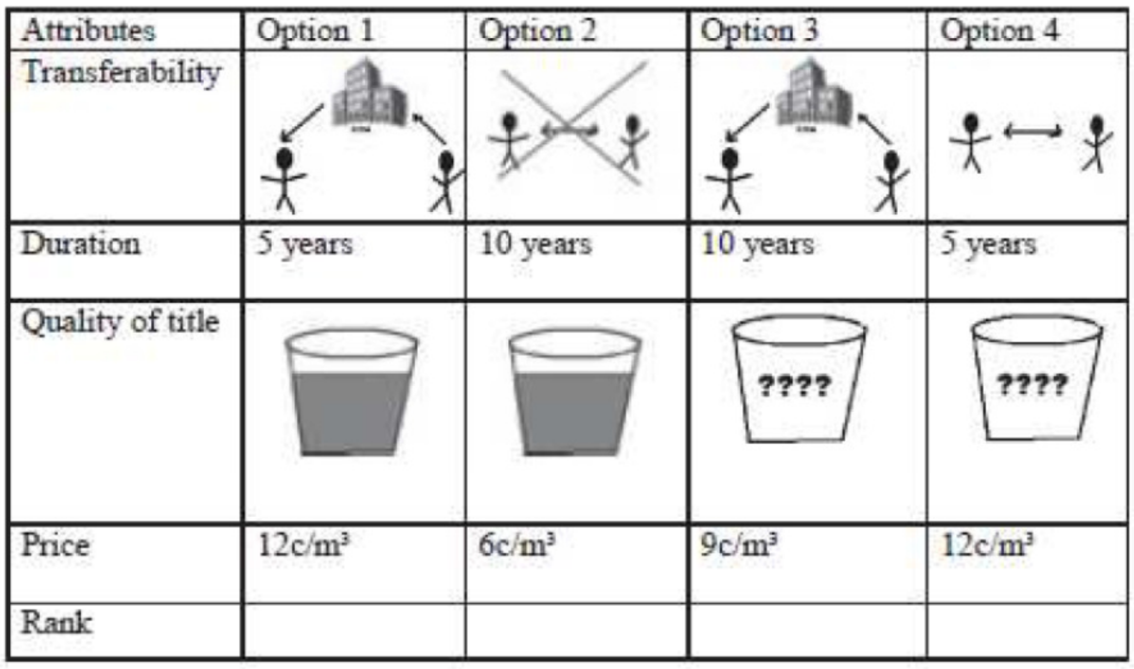

Fig 1. Choice Set Example used for the South African case study

With all attributes and levels known the choice sets can be designed. For the South-African case study a three step approach described in Speelman et al., (2010a) was used to generate a design consisting of three blocks of three choice sets each containing four water rights configurations. An example of a choice set used in the South African choice experiment is provided in Fig 1. For the Indian case study SAS macros (see Kuhfeld, 2005 for details) were used to develop a generic choice design. The choice design comprises 16 choice sets, blocked into four groups. Each choice set consists of four alternatives, including a status quo. An example is presented in table 1.

Table 1. An example choice set

If options crop price, quota price, volumetric price, area price were only available, which one would you chose?

Characteristics	CP	BP	VP	AP (status quo)
Duration	Long	Short	short	Short
Supply	Not-guaranteed	Guaranteed	Guaranteed	Not-guaranteed
Water transaction	Within WUA	No-Transfer	Between WUA	No-Transfer
Payment	450 Rs	2100 Rs	30Rs/acre-inch	150 Rs
I choose	☐	☐	☐	☐

4.2 Data collection

The South African data were collected in April 2008 in the Limpopo province of South Africa. A sample of typical South African smallholder irrigation schemes was established. Both larger irrigation schemes with over 100 farmers and smaller schemes, with only 30–40 farmers, were included in the sample. Furthermore, it was also ensured that differences in cropping patterns reflecting varying degrees of water scarcity were covered. In total, seven irrigation schemes were chosen from the national database of small-scale irrigation schemes. Within the schemes, about 30% of farmers were randomly selected from a list of active farmers. Structured questionnaires were used capturing detailed information regarding farming activities, alternative income sources and other relevant institutional aspects of water management as well as a contingent ranking experiment on irrigation water rights. In total, 134 questionnaires were completed, which provided 402 choice sets for analysis.

In India, data were collected from farmers in the Krishna river basin area of northern Karnataka state between January and March 2008, using face-to-face interviews. The study area consists of four sub-basins, namely Lower Krishna, Ghataprabha, Malaprabha and Tungabhadra. In two steps the villages, and farmers within the villages, were selected. First a list of villages was collected from the district headquarters and arranged in alphabetical order. Randomly 8, 6, 6 and 12 villages were selected respectively from the Lower Krishna, Ghataprabha, Malaprabha and Tungabhadra sub-basins. Then the farmers were randomly selected from each village. A pilot study, involving 30 farmers from non-selected villages, was undertaken to check the validity of the experimental design. Some changes were made before conducting the actual choice experiment. From the selected villages, 320 farmers were interviewed in their homes. 30 farmers did not fully complete the interview and were hence discarded from the analysis. During the face-to-face interviews with farmers, detailed information was provided to them on each water pricing method, as well as on the attributes of the water rights and their levels.

4.3 Analysis

The data collected in South Africa were analysed using a latent class model (LCM). This type of model, which CE practitioners have started employing most recently, allows accounting for preference heterogeneity. The underlying theory of the LCM posits that individual behaviour

depends on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst. This heterogeneity can be captured through a model of discrete parameter variation. Thus, it is assumed that individuals are implicitly sorted into a set of Q classes, but which class contains any particular individual, whether known or not to that individual, is unknown to the analyst (Greene and Hensher, 2003). In the LCM, the population consists of a finite and identifiable number of groups of individuals (i.e., segments or classes), each characterised by relatively homogenous preferences. These classes, however, differ substantially in their preference structure. This approach can accommodate preference heterogeneity while allowing for the number of classes to be determined endogenously by the data. In the LCM, belonging to a class with specific preferences is probabilistic, and depends on the social, economic and attitudinal characteristics of the respondents (Birol et al., 2006).
The data of the Indian case study are analysed using a multinomial probit model (MNP). The computational complexity of fitting the MNP model (Train, 2003) and its requirement for highdimensional integrations, has limited the application of this very useful and appealing model (Imai and van Dyk, 2005). However, based on Gibbs sampling with data augmentation and the development of an efficient Markov Chain Monte Carlo (MCMC) algorithm the computational difficulties involved in MNP were reduced. Following McCulloch et al. (2000), Imai and van Dyk (2005) and Alvarez and Katz (2009), the observed choice of water pricing method is modeled in terms of utility differentials (see Veettil et al., 2011b for more details).

5. Results and discussion

5.1 Respondents' characteristics

In South Africa 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. This picture of an aging and low educated farming population cultivating small plots at smallholder irrigation schemes in rural South Africa is drawn by several authors (Perret, 2002; Hope et al., 2008). On average the respondents produce 4 crops. In the drier parts of Limpopo most farmers only grow maize during the wet summer season. In other parts of the province production is more diversified, with the majority of the farmers producing maize in summer and a wide variety of crops in winter. Spinach, beans, beetroots, cabbages and tomatoes were the most important winter crops in the sample. The monetary income generated by irrigated agriculture is quite low. 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, 2002; 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. Furthermore most production is subsistence-oriented.

In India the age of the respondents varies from 24 to 75 years with an average of 52 years. The mean household size of the sample is 5.83 persons. More than 25% of respondents did not benefit from formal schooling. Most of the sampled farmers irrigate their land and the average irrigated land size is 2.47 ha (6.12 acres), whereas 1/6 of the sampled farmers additionally possesses dry land with an average size of 0.4 ha (1 acre). Two sources of irrigation water are used: groundwater (open well or tube well) within or nearby the farm and surface water-canal irrigation. Some farmers use a combination of both. The average distance to a groundwater source is less than 1 km (0.62 mi). The most cultivated crop is rice. The average distance to the market from the farm is 21 km (13 mi).

5.2 Results from the choice experiments

a. South African case study

Because the 2-segment solution provided the best fit to the data, the results of the 2-segment LC model are reported in Table 2. The first part of the table displays the utility coefficients from water rights attributes, where the second part reports the segment membership coefficients. The segment membership coefficients for the second segment are normalized to zero in order to identify the remaining coefficients of the model (Birol et al., 2006). The other coefficients are interpreted relative to the normalized segment. For segment 1 the utility coefficients for all attributes except the transferability attributes are significant and the segment membership coefficients reveal that having trust in the water management institutions and being male decreases the probability that a respondent belongs to the first segment. The other factors do not significantly affect membership. For the second segment all attributes are significant determinants of the choice, and except for the price attribute, higher levels of these attributes increase the likelihood that respondents in segment 2 choose a water right specification. The effect of a higher price is significant and is again negative for this segment.

For each respondent the probability of belonging to either one of the two segments can be determined. Based on their largest probability score the respondents are assigned to the segments. In this study 36.5% of the sample belongs to the first segment and 63.5% belongs to the second segment. The descriptive statistics for the social, economic and farming characteristics of each segment are reported in Table 3. A significant higher proportion of respondents in the second segment is male, they are better educated, have more trust in water management institutions and are spatially located closer to the schemes' water intake. On average they have both higher non-farm and farm incomes, but for irrigation income the difference with segment 1 is not significant. Age, household size and occurrence of water conflicts also do not significantly differ between the two segments.

Table 2 Results of the conditional logit and latent class models

	CL model	LC model	
		Segment 1	**Segment 2**
Duration	0.096*** (0.014)	0.126*** (0.033)	0.112*** (0.011)
Quality of title	0.628***(0.038)	3.19*** (1.211)	0.318*** (0.029)
Price	-0.048***(0.015)	-0.140*** (0.039)	-0.031** (0.013)
Agency based transfer	0.230***(0.050)	-0.093 (0.112)	0.355*** (0.037)
Market transfer	0.360***(0.051)	0.902 (0.106)	0.509*** (0.046)
Segment function: respondents' social and economic characteristics			
Constant		1.221 (1.340)	
trust in WM[a]		-0.629 ** (0.298)	
age		-0.014 (0.016)	
gender		-1.020 ** (0.455)	
Yirr[b]		-0.327 (0.934)	
Conflict[c]		-0.181 (0.479)	

[a] 5 point likert scale score indicating whether respondents have trust in the water management institutions
[b] the share of irrigated agriculture in the monetary income of the household
[c] dummy variable indicating whether respondents have already experienced conflicts regarding irrigation water
***1% significance level,** 5% significance level, *10% significance level with two-tailed tests.

Table 3 Profiles of respondents belonging to the two segments

	Segment 1 (n=49)	Segment 2 (n=85)
Gender (% male) ***	22	45
age	56 (11.5)	60 (14.1)
Household size	6.7 (3.0)	6.2 (2.5)
Education**	4.4 (4.2)	6.3 (4.5)
Field situation		
Head %	35	47
Middle %	35	25
Tail %	30	28
Water conflicts (% no)	46.	47
Trust in WM *** (average score)	2.2 (0.8)	2.6(0.9)
Nonfarm income ***(R)	12551.5 (9633.5)	19048.2 (19323.4)
Irrigation Income	1732.2(2757.5)	2140.8 (2826.3)
# crops	3.9 (2.6)	4 (2.6)
Water shortage (% no)	38	39

T-tests and Pearson Chi square tests show significant differences (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

The difference in attitude towards agency based water right transfers, which was revealed in table 4, could be explained by the level of trust in the water management institutions. It is interesting to see that the respondents in segment 1 which have a significantly lower trust in the water management institutions, dislike the idea of an system of agency based transfers, while for the respondents in segment 2, preference is clearly positively influenced by such a system. Respondents from the first segment are also more sensitive to the price attribute. This is in line with the expectations based on their profile, because several characteristics (income levels, gender, field situation, education level) seem to indicate that the respondents in segment 1 are poorer than those in segment 2. The price coefficient and the lower coefficients for most other attributes 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). Finally a plausible explanation for the larger preference for water rights with longer durations among respondents in segment 2 could the positive relationship between education and investments in productivity. This relationship implies that better educated people are more inclined to make such investments, but as explained by Backeberg (2006) such investment decisions are negatively affected by a short duration of the licenses.

b. Indian case study

Table 4 presents the results of the MNP model. The parameter estimates denote the marginal utility associated with a change from the attribute levels under the existing AP system. The alternative specific constants denote the preferences for other WPMs compared to AP, with the other attributes at the baseline level. From the water right attributes only changes in transferability seem to significantly change utility. The signs of the parameter estimates of attributes are as expected, i.e., the choice probability (and utility) of area water pricing will increase with water transaction within WUAs, between WUAs, and water-market. By contrast, the price is negatively correlated with choice probability, which means that a higher water price decreases the preference for area-water pricing. Furthermore the dummy variable “price-high” captures the adverse effect of a high price level on the choice probability for a water pricing method (Alfnes et al., 2006). Finally it can be noted that the presence of a WUA negatively affects the utility of changing the WPM.

Further analysis can reveal whether complementary relationship exists between changes in the water rights system en changes in the water pricing. Existence of such relationship could explain why individual water rights attribute changes did not have a significant effect. The WTP for combinations of WPM, the presence of decentralised water governance (WUAs) and water rights definitions are calculated and reported in Table 5.

Table 4 Parameter estimation of MNP choice model

Coefficients	Mean (Std error)		[95% Bayesian credible interval]
Intercept			
CP/AP	−1.364** (0.828)		[−3.3666, −0.128]
BP/AP	2.142** (0.969)		[0.6418, 4.486]
VP/AP	0.277 (0.775)		[−1.4927, 1.695]
Transferability			
Within WUA	1.214* (0.83)		[−0.0176, 3.193]
Between WUA	2.315 **(1.406)		[0.2917, 5.749]
Water market	1.325** (0.834)		[0.0458, 3.289]
Duration	0.292 (0.352)		[−0.252, 1.140]
Supply reliability	−0.306(0.372)		[−1.040, 0.465]
Price	−1.735** (0.813)		[−3.741, −0.445]
Price high dummy			
CP/AP	0.545* (0.291)		[−0.013, 1.125]
BP/AP	−2.164** (1.28)		[−5.245, −0.335]
VP/AP	0.563 (0.707)		[−0.582, 2.213]
WUA dummy			
CP/AP	−0.541* (0.29)		[−1.086, 0.053]
BP/AP	−2.881** (1.393)		[−6.289, −0.758]
VP/AP	−1.752** (0.982)		[−4.161, −0.339]
Irrigated land			
CP/AP	0.018 (0.022)		[−0.026, 0.063]
BP/AP	0.071** (0.051)		[0.0069, 0.198]
VP/AP	0.055* (0.046)		[−0.0051, 0.168]
Variance–covariance			
CP/AP: CP/AP	1	0	
CP/AP: BP/AP	0.4486	1.2353	[−2.4476, 2.7957]
CP/AP: VP/AP	1.1596	1.1196	[−1.1887, 3.4032]
BP/AP: BP/AP	6.1917**	6.9917	[0.3112, 24.9739]
BP/AP: VP/AP	5.4101**	6.0933	[0.2004, 21.2792]
VP/AP: VP/AP	6.2221**	7.0012	[0.2194, 23.7224]

*Significant at 90%., **95% level of Bayesian credible interval.

These WTP estimates are relative to the base scenario with AP, absence of local water governance and poorly defined water rights. In all types of relationship between pricing, local governance and water rights, the presence of WUAs causes a decline in WTP when compared to that of a similar scenario without the presence of a WUA. Thus we conclude that there is no complementary relationship between the existence of local water governance and pricing, or between the existence of local water governance and water rights. By contrast, complementarity is evident between water pricing and water rights. Highly complementary relationships are evident between BP and water rights (WTP=Rs. 2000/acre for 50 acre-inch of water), as well as between VP and water rights (Rs. 18/acre-inch) when there is no WUA. When the block is coupled with long duration water rights, the scope for investment also increases. The firstbest efficient water pricing can be obtained under BP when the transfer of water rights is permitted via a water market. The duration of water rights and their transferability provide the farmer with incentives to use water efficiently. In our result, less restrictions in transferability lead to a higher WTP. A possible reason as observed by Dridi and Khanna (2005) might be that water transfers increase efficiency. Guaranteed supply ensures the timely supply of irrigation water, as prescribed in a water contract. But improvements to the water governance structure are necessary to effectively taper the complementary relationships existing between water pricing and water rights.

Table 5 Marginal WTP estimates for complementary relations

Water pricing	Local water governance	Water rights	WTP (Rs./acre-inch)
CP	Absent	Poorly defined	−15.72
CP	present	Well defined	−21.96
CP	Absent	Poorly defined	−0.45
CP	present	Well defined	−6.69
BP	Absent	Poorly defined	24.69
BP	present	Well defined	−8.52
BP	Absent	Poorly defined	39.97
BP	present	Well defined	6.76
VP	Absent	Poorly defined	3.19
VP	present	Well defined	−17.00
VP	Absent	Poorly defined	18.47
VP	present	Well defined	−1.73

a Base level: Area pricing with the absence of local water governance and poorly defined water rights.

5.3. Discussion

A common result from both case studies in this paper is that farmers appear to be willing to pay more for water when water rights are better defined. This could be because they believe that such improvements decrease their transaction costs or increase the efficiency of the production system (thus decreasing the cost). However, some features of water rights are more important to farmers than other. The preference structure differs between case studies, but also among farmers within the same case study.

One of the water right attributes considered in this study was quality of the title. Some authors argue that a key factor for the adoption of water saving in irrigation is the availability of a dependable and timely water supply (Mushtaq et al., 2009). Lack of reliable water sources or uncertainty in water supply can play a major role in water management and the subsequent adoption of water-saving measures (Mushtaq et al., 2009). Moreover, Kemper (2001) states that without a clear definition of who the users are and how much water they are entitled to, the users themselves have no incentive to use the water efficiently because they have no guarantee that if they save water today they will receive more tomorrow. Both case studies included an assessment of the importance which farmers attach to knowing how much water they will receive. Previous studies in the South of Spain by Alcon et al. (2008) and Rigby et al. (2010) and in Australia by Freebairn and Quiggin suggest that generally farmers highly value certainty of supply. While in South Africa this appears to be the case and high importance is attached to guaranteed water supply, in India the attribute on itself was not significant. Possibly this is linked to the access to groundwater which these farmers in India might have. This role of groundwater as an alternative water source was also reported by Marquez et al. (2005).

Transferability of water property right was found to be of high interest for farmers in this study. Making the water rights transferable has a large positive effect on farmers' WTP for irrigation water in India and South Africa. Theoretically, making water entitlements transferable would also allow the reallocation of rights on the basis of economic efficiency, while providing a compensation mechanism (Molle et al., 2004). This is in line with neoclassical economics, which see property rights as a fundamental concept of development, or even as the core of capitalism (De Soto, 2000; Demetz, 1973, in Molle et al., 2004). Several other studies have focused on the potential beneficial effects of the introduction of water markets in India and South Africa (Nieuwoudt & Armitage, 2004; Manjunatha et al., 2011). However, Pujol et al. (2006) also points to some limitations of water markets. They state that tradable volumetric water rights, decoupled from land rights, are essential for an efficient water market, along with a reinforcement system and conflict resolution mechanism. This therefore implies that water markets are more acceptable in a system with welldefined water rights and a high degree of trust (Pujol et al., 2006). In addition to clearly defined and transferable water rights, water markets moreover also require physical infrastructure that will allow water to be transferred from one user to another, and institutional arrangements to protect against negative impacts on third parties when water is transferred; which are rarely found in developing countries (Easter et al., 1998). Such a lack of infrastructure was also mentioned by Tsur (2005).

While decentralization and water management transfer is still an ongoing process in South Africa, the case study in India showed that farmers appreciation of the local water governance (mainly concerning the performance of the WUA) strongly affects their WTP. The problems of poor performance, inefficiency and lack of objectivity of WUAs and other local water governance organisations seem to impair the efficiency gains by other reforms. But also in South Africa trust in water management institutions was shown to be an important factor. There it was one of the variables explaining segment membership. It is therefore important for the governments in developing countries to enhance performance of local water management institutions and to increase the trust of farmers in these institutions, since this will increase their WTP for the proposed interventions in the water rights. In South Africa particularly the link between trust and the preference for transferability was clear, which is in with the claim of (Pujol et al., 2006).

Finally the Indian case study shows that water rights reforms should not be considered as separate action with expected outcome, but as a tool among a whole reform package including effective pricing methods, better local governance of water, and technical modernisation of the irrigated areas. Kemper (2001) relates this to the fact that all actors are responsive to incentives. Incentives are provided by the institutional arrangements including (i) the water (use) right, (ii) the price of water, (iii) the existence of law mandating a certain way to use water (e.g., recycling, or the maintenance of environmental stream flows in river beds), (iv) the enforcement of such laws and regulations (monitoring) through a sanctioning system (e.g., fines, peer pressure) and (v) the access to information about all of the above. Complementarity between reforms is also recognised by Mollinga et al. (2007) when they state that transferring management of irrigation infrastructure to farmers is more likely to succeed where farmers' water rights are specified, legal support for farmers' organisations is available, infrastructure is designed for decentralised management, and the property status of the infrastructure is clear.

6. Conclusions

In the current context of increasing water scarcity in many developing and developed countries, institutional options and tools for improved water allocation and governance become an urgent research priority. However, evaluating institutional alternatives, such as water rights systems, is a challenging task. From methodological point of view, the current work shows that choice modelling could be of high interest to overcome this challenge. Choice experiment were successfully used to assess the farmers preference for hypothetical property rights scenarios assuming improvement of the water rights definitions. The results were consistent and provided interesting information about farmers' preferences for different dimensions of the water rights in the two considered countries: India and South Africa. The WTP estimates for changes in the water rights system could be interpreted as differences in transaction costs. Overall, the estimation of WTP indicates that significant inefficiencies exist in the current water right system in the considered countries.Tackling these inefficiencies will not only be favourable for the efficiency of water use of smallholder irrigators, but given the size of the benefits, could also add significantly to the government objective of cost recovery, which is a hot issue in many developing countries. With a higher WTP for water there is also more scope for government to increase water prices for irrigators and to reach higher cost recovery rates.

Finally, it should be mentioned that the results drawn in this study should be considered as a part of a broader framework. In addition to the transaction costs borne by farmers (on which we assume they base their choice and preferences for different property rights systems), there is also another type of transaction costs corresponding mainly to the public costs of implementation and maintenance of the different institutional alternatives, in addition to the costs of institutional change itself (Challen, 2002; McCann & Easter, 2004). These costs should be considered by policy maker when examining different institutional options for agricultural water management.

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