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# **Water communities in the Republic of Macedonia: an empirical analysis of membership satisfaction and payment behaviour**

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## **Abstract**

Utilizing primary survey data, we investigate the performance of Water Communities (WCs), a form of self-managing organisation for irrigation, in the Bregalnica region of the Republic of Macedonia. While their introduction improved cost recovery, only modest changes occurred in the cost of irrigation water and many farmers remain indifferent to the WCs. Econometric analysis focuses on the decision of farmers to join a WC, determinants of farmers' satisfaction with WCs and factors associated with changes in payment behaviour. Key determinants identified include transparency and trust regarding the conduct of WCs, cost recovery rates, farm size and irrigation costs. Membership satisfaction is an important determinant of payment behaviour.

## **Key Words**

Irrigation, Self-management, Water User Associations, Macedonia

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## **1. Introduction**

Both developed and less developed countries have witnessed a broad shift in policy away from state based irrigation management towards supporting the creation of private and independent, not-for-profit arrangements, particularly local Water User Associations (WUAs). This movement, promoted by nation states and international agencies such as the International Fund for Agricultural Development and the World Bank (Vermillion and Sagardoy, 1999), is often referred to as irrigation management transfer (IMT). While WUAs are widely seen to have the potential to be a superior institutional arrangement for local irrigation management, delivering meaningful benefits to farmers and taxpayers, their performance, in practice, has been patchy (Araral, 2005a; Meinzen-Dick *et al.* 1997; Meinzen-Dick, 2007). There is therefore a need to carefully evaluate the performance of WUAs and understand the principles that underpin successful self-government.

The paper addresses this debate by evaluating the success of the introduction of Water Communities (WCs) in the Republic of Macedonia, where agriculture is the mainstay of rural livelihoods and substantial water deficits occur during the summer season, so that irrigation has a major impact on yields and hence incomes (Taseva, 2000). By comparing performance across several WCs, which are a form of WUA that were created within a common external environment and institutional framework, it is possible to identify internal principles and qualities that are critical to success and determine variations in outcomes. The identification of factors that underpin self-sustaining WUAs, is particularly pertinent for states in Central and Eastern Europe (CEE), that have undergone a transition from central planning to more market based economies. This transition in agriculture was characterised by substantial falls in agricultural output and decapitalisation (Macours and Swinnen, 2002). Much state owned irrigation fell into disrepair and the establishment of local self-governance for economically sustainable irrigation has been seen widely as an essential task (Zhovtonog

*et al.* 2005), although some have doubted whether this can be achieved currently in the Balkans (Theesfeld, 2004).

The contribution of this paper is three-fold. First, we investigate the importance of internal factors in explaining the performance of WUAs, drawing on data for the Bregalnica region of Macedonia. Second, we apply appropriate econometric techniques to model farmers' satisfaction with WUAs and payment behaviour, responding to Araral's (2005a, p.61) criticism that the IMT literature suffers from a failure to 'employ rigorous statistical techniques'. Finally, despite the importance of irrigation for agriculture in much of CEE and notwithstanding some notable exceptions (Theesfeld, 2004), studies of IMT and the prospects for successful self-management in the region remain rare.

## **2. Determinants of the Success of Self-Managing Organisations**

WUAs can be defined as not for profit organizations that are initiated, and managed by a group of water users along one or more hydrological sub-systems (IWMI, 2003). Farmers that agree to become members of the WUA, pool resources for the operation and maintenance of the irrigation and drainage system within their jurisdiction. The theoretical justification of WUAs is based on the Common Pool Resource (CPR) management literature, particularly the writings of Ostrom (1990, 1992). Irrigation is conceptualised as a CPR in that there is an asset to be managed (physical infrastructure) and a stream of benefits (distribution of water) that require group management because it is typically difficult to restrict access to individual members (non-excludability) but the use of a particular amount of water by one user depletes the resources available to others (rivalrous consumption) (Bromley, 1992; Ostrom, 1990). The difficulty of exclusion increases individual incentives to free ride, potentially endangering the CPR. To protect the latter, state control has been adopted frequently but in practice many state-managed irrigation systems perform poorly. In particular, state financed and managed

technological solutions in irrigation have often fostered an unhealthy dependence on external aid (Araral, 2005b) and failed at the local level due to ineffective monitoring and enforcement of rules (Vandersypen *et al.* 2006).

In the case of irrigation, Ostrom (1990, 1992) argues that self-management may be preferable to state ownership, with WUAs *potentially* improving farmer welfare in three regards. Firstly, water delivery services may improve because local farmers have stronger incentives to distribute the water effectively and better information about irrigation needs than external state agencies (Meinzen-Dick *et al.* 1997). This should reduce costs. Secondly, system maintenance may improve under WUA arrangements as farmer members are more likely to care for irrigation systems if the WUAs must bear the costs of repairs (Merrey and Murray-Rust, 1991). As the care and use of irrigation systems improves, so agricultural productivity, and hence incomes, should rise (Meinzen-Dick *et al.* 1997; Yercan *et al.* 2004). Finally, some have argued that local systems will be better able to control and prevent opportunistic behaviour, increasing fee-collection and improving the financial viability of irrigation systems (Svendsen and Murray-Rust, 2001; Yercan *et al.* 2004). Such an outcome would reduce dependence on state funds.

Despite these theoretical benefits of self-organisation, sustainable WUAs often fail to emerge in practice (Baland and Platteau, 1996; Tang, 1992; Meinzen-Dick, 2007). Recognising this, Ostrom (1990), attempts to identify factors that are associated with positive outcomes. She concludes that, based on case study evidence, successful self-managing institutions are characterised by: clearly defined boundaries, congruence between the distribution of benefits and costs of provision rules, democratic decision making, effective monitoring, graduated sanctions to punish those who violate operational rules, mechanisms to resolve conflicts, and external recognition of the right to organise. The ability of a particular institution to meet these requirements, according to Ostrom (1992), depends on both *internal*

characteristics and the *external environment* (Table 1). The main external factors identified by Ostrom (1992) as conducive to successful WUAs are effective legal rights to organise and negotiate and established property rights and markets for crops. As the WCs in Macedonia were created under a common legal framework and support programme, and thus a shared external environment, we concentrate on internal factors which are split into four sub-categories: socio-economic characteristics, structure and conduct of the WUA, irrigation technology and costs (Table 1). It is expected that these factors influence the probability of successful self-management and provide the basis for testing hypotheses in Section 5.

#### *Socio-economic factors*

Irrigation will be most valued in environments of moderate water scarcity (Araral, 2009; Meinzen-Dick, 2007). Where water is plentiful the pressure for self-organisation of irrigation facilities is minimal and at the other extreme if the scarcity of water is so severe that even self-organisation cannot solve the problem, co-operation is unlikely (Araral, 2005a). In other words, resource scarcity and collective action are related in a curvilinear manner (Araral, 2009) with significantly co-operation less likely to occur when water is superabundant or extremely scarce. In cases of moderate water scarcity the impact of irrigation is likely to be greatest, presenting attractive potential returns from self-organisation.

The impact of irrigation is likely also to be greater where farmers produce crops that consume considerable water and are sensitive to moisture stress (Meinzen-Dick *et al.* 1997). Marshall (2004) therefore asserts that where irrigation is more critical for their livelihood, farmers have greater incentives to co-operate to ensure a functioning irrigation system. Wade (1988) and Araral (2009) also suggest commitment to WUAs will depend positively on salience – the extent to which users depend on the resource for their livelihoods.

It is expected that younger and better educated farmers are more likely to appreciate the benefits of WUAs, and thus become a member and value the benefits. Meinzen-Dick (2007) found, for India, that the presence of college graduates to have a significant, positive effect on the establishment of WUAs. Huang *et al.* (2009), in their study of WUAs in northern China, found a positive relationship between the education of villagers and adoption of institutional reforms to manage water (either formation of a WUA or contracting). They suggest that education may be linked to a greater willingness to embrace reform or clearer appreciation of benefits. While, as far as we are aware, age has not been considered as a variable in previous studies of WUAs, findings for the management of other CPRs suggest that older citizens are less likely to engage with institutions for self-management (Mwangi, 2007).

There is no consensus on the effect of farm size on WUA performance. Shah (2000) argues that small sized farms negatively impact on the sustainability of WUAs as farmers with limited agricultural land have to seek off-farm income, which limits their stake in the irrigation system and often leads to abandonment. However, Araral (2009) found a positive relationship between farm size and free riding in the Philippines. He argues that wealthy farmers have more 'exit options' and are more detached from an irrigation organisation, which makes adherence to norms and local enforcement problematic.

### *Structure and conduct of the WUA*

The size of the group (both in terms of geographical area and number of potential members) will influence the degree of congruence between costs and benefits and the ease of monitoring / imposition of sanctions. Due to the large fixed costs connected with irrigation, the average cost of irrigation to farmers will fall as group size increases (Meinzen-Dick *et al.* 1997). However while larger groups may reduce the burden of fixed costs borne by individual



members, increases in group size are usually accompanied by higher transaction costs (e.g. negotiation) and greater difficulties in observing compliance with rules (Meinzen-Dick, 2007). As Araral (2005a, p.50) notes ‘it is a lot easier for five large farmers to come together to agree rules for self-management than for 1,500 smallholders’. In smaller groups the inter-linkages between members are also likely to be stronger with greater ‘peer pressure’ for compliance (Aggarwal, 2000). Self-managing organisations will only be sustainable where free riders are punished, for instance non-payers are denied access to water or suffer other legal means of redress.

Other important characteristics that are conducive to effective self-organisation are past successful experiences with co-operation and the presence of effective leaders who are willing to act altruistically to create the organisation (Baland and Platteau, 1996; Meinzen-Dick *et al.* 1997; Ostrom, 1990; Ostrom and Gardner, 1993). Bardhan (1993) and Meinzen-Dick highlight the importance of local leaders who can act as catalysts for co-operative action and drawing on data for Nepal, Ternström, (2002) found a significant relationship between the quality of local leadership and the sustainability of WUAs. A high level of trust between members should lower, over time, costs related to monitoring and sanctioning one another (Araral, 2005a). However, there is a danger that WUAs become subject to a takeover by local elites, denying individual members a voice and weakening their accountability (Oorthuizen and Kloezen, 1995).

### *Irrigation technology*

Easter (2000) notes that management problems vary significantly with the type of irrigation and level of technology. While direct comparisons of different irrigation technologies and their impact on WUA performance are absent from the literature, it is expected that systems that are more susceptible to free riding to be weaker. In particular, flood irrigation requires

greater quantities of water, for which it is more difficult to separate the distribution of water to payers and non-payers. In this case, effective penalties for opportunistic behaviour may be more difficult to implement. It is expected, therefore, that WUAs are better suited to certain irrigation technologies with performance varying accordingly.

### *Costs*

It is expected that farmers will value WUAs that reduce the costs of irrigation per hectare and which have high levels of cost recovery (Yercan, 2003). Case study evidence from Mexico suggests that the introduction of WUAs can dramatically boost cost-recovery and thus achieve a policy goal of reducing dependence on the state (Kloezen, 2002). It is expected that improved cost-recovery will depend on both WUAs providing a superior service to farmers compared to previous institutional arrangements and the presence of effective sanctions against opportunistic behaviour.

These four sub-categories provide the basis for organising the independent variables included in the empirical analysis.

The dependent variable, performance of WUAs, has previously been measured in three ways: formation / membership rates (Meinzen-Dick, 2007; Huang *et al.* 2009), technical impact (Lam, 1998; Tang, 1992; Yercan, 2003; Yercan *et al.* 2004) and cost recovery (Yercan, 2003; Araral, 2009). Technical impact has been assessed in terms of changes in yields / agricultural efficiency, water availability and area irrigated. Such assessments are typically based on expert opinion with little recourse to the views of ordinary members. As Araral (2005a, p.61) notes most IMT studies ‘excessively rely on irrigation agency data and are seldom validated independently’. Yet the sustainability of WUAs will depend ultimately on the satisfaction and retained membership of farmers. Moreover, notwithstanding some notable exceptions (Tang, 1992; Araral, 2009) previous assessments, have tended to be based

on comparisons of WUAs from different countries and market environments making it hard to identify the relative importance of external factors compared to member / resource characteristics in influencing performance (Johnson, 1995). Our analysis recognises these difficulties and compares the performance of WUAs created in the Bregalnica region of the Republic of Macedonia under a common legal framework and time period. This allows for a comparison of cases with a similar external environment and therefore a clearer understanding of the role of internal (to the WUA, farm and farmer) factors. Performance is measured in terms of propensity to become a member, member satisfaction and farmers' payment rates (% of the billed amount paid by farmers).

### **3. Water User Associations in Macedonia**

Given our interest in investigating the importance of internal factors in explaining the performance of WUAs, the Bregalnica region of Macedonia is an appropriate case study. Bregalnica is a semi-arid region for which irrigation is important. Rainfall is approximately 500 mm per annum and occurs principally in Autumn and Spring. Due to dry, hot summers, with temperatures regularly reaching 40 degrees, water deficits of approximately 450 mm for crops typically occur (World Bank, 2006).

The main crops grown in the Bregalnica region, as identified by survey work conducted by the authors, are wheat, maize, barley, alfalfa, rice, peppers, tomatoes, watermelons and grapes. Average self-reported non-irrigated wheat and grape yields, for the years 2002-4, were 80 and 58% of irrigated levels respectively. Rice, pepper, tomato and watermelon production are entirely reliant on irrigation. As fruit and vegetables are the main high value added crops produced, agricultural incomes are heavily dependent on irrigation and this is acknowledged by farmers. From the farm survey discussed in greater detail below, 94% of respondents agreed or strongly agreed with the statement that 'irrigation is very

important for my livelihood'. Depending on topographical conditions and the type of crops, the structure of irrigation varies from flood irrigation for rice to, much more commonly, open channels and concrete tubes for arable and horticultural production.<sup>1</sup>

Table 2 summarises the development of WUAs in Macedonia. As agricultural fortunes and the real level of public expenditure on rural infrastructure fell in the 1990s, the quality of the irrigation network deteriorated rapidly. For example for Macedonia as a whole the area irrigated fell from 84,879 hectares (ha) in 1990 to a low point of 25,343 ha in 2002 (Taseva, 2004). In the Bregalnica case, the irrigated area declined from 59% of total utilized agricultural area in 1990 to 26% in 1996 (World Bank, 1997). During the 1990s, many of the concrete channels became cracked and pumping stations moribund. Water can easily be stolen from such a system with it being common for farmers to punch holes in channels to irrigate their land without paying. A representative of the Kocani Public Water Authority estimated that at least 20% of irrigation water in the Bregalinca region was lost due to theft, leaks and transpiration from open channels (Peshevski *et al.* 2006).

To improve technical and governance efficiency, at the beginning of 1998 a new Water Law came into effect and a project for the rehabilitation and reconstruction of irrigation in Republic in Macedonia commenced. The basis for this was an agreement between the Government of Republic of Macedonia and the World Bank. The project was valued at \$32.5 million of which the World Bank committed \$12.5 million, the Dutch Government \$12 million and the Macedonian Government \$8 million. The project covered three irrigation systems: Tikves, Bregalnica and Polog. The purpose of the project was to reconstruct irrigation systems, making their use sustainable through introducing better technology and local management. We focus on Bregalnica, a small region which covers less than 20,000 hectares (ha) in total.

In January 2002, a protocol for transferring irrigation management duties to Water User Co-operatives (WUCs) was signed. The first six WUCs (Istibanja, Orizari, Trkanje, Vidovište, Obleshevo and Zrnovci) were established in May 2002. These six institutions collectively cover a territory of 2,922 ha and are located close to the head of the system. In 2003 the WUCs were renamed, according to the Water Users Law, as Water Communities (WC). WCs are controlled by a management board, led by a President, and control board. The management board consists of at least five people, of whom the President and two others are chosen by WC members and the other two are selected by the Council of Local Communities. The management board makes decisions concerning the rates and deadlines for payment for irrigation and drainage. The control board, consisting of five other members, oversees the work of the management board and monitors costs on behalf of the community. By May 2005, 25 WCs had been established in the Bregalnica region.

WCs can be formed where the participants in a given area account for more than 50% of agricultural land in the community's territory and wish to manage irrigation and drainage matters collectively. Membership is open to all with the right to use agriculture land within the geographical boundaries of the WC.

Membership of WCs is voluntary. There are no joining or membership fees *per se* but a member may be excluded if they fail to pay their water bill. The community sets the prices for water and drainage to its members, which should reflect the true costs of delivering irrigation water, maintaining and improving the network and ensuring adequate drainage. WCs are responsible for the collection of water fees from members. At the time of the transfer of irrigation management duties to the first set of WCs (May 2002), data from the Bregalnica-Kocani PWE indicated that the average cost recovery rate was 36%.<sup>2</sup>

WCs negotiate the supply of water from a Public Water Enterprise (PWE) on behalf of their members. Previously, farmers were billed for water by PWEs directly. According to

the terms of establishing a WC, members were initially charged 70 per cent of the previous, base price for irrigation. Of this 70 per cent, 50 percent is paid to the relevant PWE and the other 20 per cent is retained by the WC to cover their costs and pay for remediation and reconstruction. For example, if the base price for water was previously 7,000 Macedonian Denar (MKD) per ha per annum, after formation of a WC members pay 4,900 MKD to their WC of which 3,500 MKD goes to the PWE and 1,400 MKD is retained by the WC. The base price for irrigation water is set by PWEs. In Bregalnica it depends on the type of irrigation and crop grown. For instance in 2001, flood irrigation of rice cost 9,000 MKD (\$132) per ha, furrow irrigation of maize and horticultural crops 7,000 MKD (\$103) and 8,000 MKD (\$118) per ha respectively. Reducing the cost of irrigation to farmers was a major objective of IMT in Macedonia (World Bank, 1997). The specific functions of WCs in Macedonia are thus to: collect water fees from farmers and pay the relevant PWE, establish a plan with the relevant PWE for the weekly scheduling and distribution of irrigation water, and maintain the distribution (tertiary) networks.

#### **4. Data and Econometric Methodology**

##### *Data*

Data on the performance of the WCs was collected via two methods. Firstly, in-depth interviews were conducted, with the president or a senior member of the management board for twelve WCs established in the Bregalnica region, including all of first six WCs created. The interviews collected information on the geographical area covered by the WC, membership, investment, main problems encountered and cost recovery. Secondly, to understand the reasons for the variation in WC performance in greater depth and to investigate the determinants of member satisfaction, we conducted a farm survey. To obtain data for the first three years of the existence of each WC (2002 to 2004), sampling

concentrated on the first six WCs established. In total, 249 survey responses were collected through face to face interviews. After collecting quantitative data, interviewers solicited additional qualitative responses regarding the operation and performance of WCs. Data collection occurred in 2005/6.

The survey responses are divided into two groups: members of a WC ( $n=223$ ) and non-members ( $n=26$ ). The inclusion of non-members in the study allows us to understand the determinants of membership. Estimates from senior managers of the WCs suggest, that on average, approximately 87% of farmers in the geographical area covered by the WCs have joined. This suggests that the sample is broadly representative in terms of the balance of members and non-members.

The majority of farmers who are WC members farm less than 2 hectares. Less than 5% of farmers in this group manage more than 20 hectares and the mean size for this group is 5.89 hectares. Comparing these figures with those for non-members, it appears that the latter tend to farm smaller areas with 61.5% operating on less than 1 hectare. The mean farm size of non-members is significantly lower (2.15 hectares). Overall, the prevalence of farms of less than 2 ha in the sample is in line with other estimates for Macedonia as a whole (World Bank, 2006). However a detailed analysis of the representativeness of the sample is impossible because the last population census for the country was conducted in 1981 and no agricultural census has been administered since 1964. The Macedonian Ministry of Agriculture, Food and Water Economy estimates that there 180,000 individual farms in the country with an average size of 1.4 ha but this is based on an extrapolation of the data from 1981 (World Bank, 2006). A descriptive summary of the data set used for estimation is presented in Appendix 1.

Using these cross-sectional survey data we estimate, as a first step, a Heckman selection probit model to identify causal factors related to farmers' decisions to join a WC. Based on these estimates we calculate the inverse Mill's ratio to account for possible selection

bias with respect to the estimation of the outcome equation (an ordered probit model of farmers' satisfaction with their WC). Secondly, we thus investigate determinants of farmers' satisfaction with their membership of WCs including, beside other explanatory variables, the inverse Mill's ratio from the Heckman selection model. In a third modelling step we identify significant factors underpinning changes in farmers' water payment behaviour by estimating a censored least absolute deviations (CLAD) model based on a non-parametric estimator. Here the estimates for water community membership satisfaction gained from our second model are used as an explanatory variable beside other socioeconomic characteristics. From this procedure we assess if farmers' satisfaction with water services can explain some of the variation in their payment behaviour. This follows empirically validated service quality models (Cronin and Taylor, 1992), which identify consumer satisfaction as a significant predictor of purchase / payment behaviour. For CPRs we would also expect that payment behaviour to be linked to effective sanctions against free-riding (Ostrom, 1992), and this is also captured in the analysis. Accounting for possible small sample bias we finally bootstrap the standard errors of all our models.

### *Model 1*

It is expected that a farmer's decision to join a water community or not is influenced by a multitude of factors: socioeconomic characteristics at the household/farm level, production and irrigation technology characteristics, as well as personal attitudes towards and experiences with irrigation and water communities in general as well as with respect to their specific, local water community. It is likely that, in these regards, the characteristics of water community members will differ from non-members. Unobservable characteristics affecting the decision to become a member will be correlated with the unobservable characteristics affecting a farmer's level of satisfaction with his/her water community membership. Selectivity bias would be present, therefore, if we were to draw inferences about the



determinants of membership satisfaction for all farmers based on the observed level of satisfaction of the subset which is actually a WC member. Heckman's (1979) two-stage sample selection model copes with such a selection problem by assuming that the farmers make two judgements with regard to membership and membership satisfaction, each of which is determined by a different set of explanatory variables. It is based on two latent dependent variables models, where the decision to become a member or not is modelled as a selection equation specified as:

$$P_i = \begin{cases} 1 & \text{if } \alpha + \sum_j \beta_j hh_{ij} + \sum_k \gamma_k att_{ik} + \sum_l \delta_l irr_{il} + u > 0 \\ 0 & \text{otherwise} \end{cases} \quad [1]$$

where  $P_i$  is a binary variable which takes the value one if the farmer is a member of the local WC and zero if the farmer decided not to become a member,  $hh$  denotes the vector of socioeconomic characteristics of the household/farm,  $att$  stands for the personal attitudes of the farmer toward the structure and conduct of the WC, and  $irr$  for the irrigation technology related variables.  $\alpha, \beta, \gamma$  &  $\delta$  are the parameters to estimate, and  $u$  is the error term (the corresponding log-likelihood function for [1] is given in Maddala, 1998).

The membership satisfaction equation is given by:

$$satis_i = \mu + \sum_m \kappa_m hh_{im} + \sum_n \tau_n att_{in} + \sum_r \omega_r irr_{ir} + \sum_s \psi_s comm_{is} + v \quad [2]$$

where  $satis$  takes the values

{1: 'very dissatisfied', 2: 'dissatisfied', 3: 'indifferent', 4: 'satisfied', 5: 'very satisfied'}

respectively,  $hh$  denotes again the vector of socioeconomic characteristics of the household/farm,  $att$  stands for the personal attitudes of the farmer toward the structure and conduct of the WC,  $irr$  for the irrigation technology related variables, and  $comm$  for water community cost related characteristics.  $\mu, \kappa, \tau, \omega$  &  $\psi$  are the parameters to estimate, and  $v$  is

the error term (the corresponding log-likelihood function for [2] is given in Maddala, 1998). Given the distribution of the dependent variable, we estimate [2] as an ordered probit model and address possible selection bias by following Heckman's two-stage estimation procedure (1979). The first stage of the estimation procedure consists of estimating equation [1] as the membership equation, the second stage of the estimation procedure is the ordered probit equation of membership satisfaction which contains the inverse mills ratio as a correcting term.

To address the likely problem of small sample bias as well as heteroscedasticity, we estimate the robust covariance matrix using the Huber-White sandwich estimator (Huber, 1967; White, 1980). The latter provides consistent estimates of the covariance matrix for parameter estimates even when the fitted parametric model fails to hold because of misspecification or violation of the error related assumptions.<sup>3</sup> To examine the validity of the final model specification, we test for the group wise insignificance of the parameters in [1] and [2] by a common generalized likelihood ratio testing procedure.

To test for small-sample bias we further investigate the robustness of our estimates obtained by [1] and [2] by applying a simple stochastic re-sampling procedure based on bootstrapping techniques (see Appendix 2). This appears necessary as our cross-sectional data sample consists of a (rather) limited number of observations.

### *Model 2*

Our second model focuses on explaining the variation in farmers' water payment behaviour. Among other variables, we also use the estimates from Model 1 for farmers' satisfaction with their water community membership as an explanatory variable beside other socioeconomic household characteristics. From this procedure we try to reveal, following service quality

models, if farmers' satisfaction with water services can explain some of the variation in their payment behaviour.

Initial analyses revealed that essential model violations (heteroscedastic error terms and a non-normal error distribution) lead to highly inconsistent parametric estimation results with respect to censored model specifications. However, there are alternative estimation procedures which do not require the adherence to these error related assumptions. Consequently, we selected a nonparametric censored least absolute deviations estimator (CLAD), developed by Powell (1984, 1986) as a generalization of the least absolute deviation estimation for non-negative dependent variables. Several authors (Arabmazar and Schmidt, 1981; Vijverberg, 1987; Rogers, 1993) demonstrate that the CLAD estimator is robust to heteroscedasticity and outliers, and is consistent and asymptotically normal for a wide class of error distributions.

Farmers' payment behaviour with respect to their water bill can be approximated by the following equation:

$$payincr_i = \max(x_i\beta + \varepsilon_i, L) \quad [3]$$

where *payincr* denotes the percentage change in the amount of their total water bill paid by the farmer in the study period from 2002 to 2004,  $x_i$  as a vector of the observable explanatory variables for farm *i* (i.e. socioeconomic characteristics of the household/farm, the personal attitudes of the farmer, the irrigation technology related variables, and water community cost related characteristics),  $\beta$  are the parameters to estimate, and  $\varepsilon$  is the error term. *L* stands for the lower censoring bound with respect to the dependent variable. The CLAD estimator of  $\beta$  minimizes the sum of absolute deviations,  $|\varepsilon|$ , assuming a conditional median restriction on the error term. The objective function can thus be specified as:

$$S_n(\beta) = \min \left\{ \frac{1}{n} \sum_{i=1}^n |payincr_i - \max \{L, \beta x_i\}| \right\} \quad [4]$$

whereby the estimator uses the observations so that the median is preserved by monotonic functions. Hence, the CLAD estimator involves the minimization of an objective function that is not necessarily convex in  $\beta$ .<sup>4</sup> The optimization procedure follows Jonston and DiNardo (1997) and comprises three steps: (i) estimating the median regression using the total sample to determine the initial values for  $\beta$ , (ii) calculating the values for the dependent variable  $payincr_i$  based on the estimated values for  $\beta$  by neglecting the observations for which  $payincr_i$  takes a negative value, and (iii) estimating the median regression based on the adjusted sample to obtain new estimates for  $\beta$ . Steps (ii) and (iii) form the iteration process to determine the final values for  $\beta$ . A generalized likelihood ratio testing procedure was again applied to examine the validity of the final model specification with respect to the group wise insignificance of the parameters in [4]. Since, finally, the estimator's asymptotic variance-covariance matrix involves the estimation of the density function of the error term, we use again bootstrap estimates of the standard errors with about 1,000 draws following the re-sampling procedure outlined in Appendix 2.

## 5. Results and Discussion

### *Descriptive Statistics*

The survey elicited the reasons for membership / non-membership of WCs. Specifically, members rated the importance of five potential factors in their decision to join a WC on a five point Likert scale (1=not important; 5=most important). The most salient factors, in descending order of importance, as ranked by mean score, were: opportunity for improvement of the irrigation system, opportunity to reduce costs of water, greater control over maintenance of irrigation equipment, ability to have greater control over delivery of water and

peer pressure. Less than 2% of members rated peer pressure as the most important factor in their decision to join and the majority regarded this factor as being not important or of minor importance. The main motivations for membership were thus to improve service quality and reduce costs.

Non-members also evaluated the importance of six potential factors in their decision not to join a WC, again on five point scale (1=not important; 5=most important). Non-members rated a lack of relevant information as the most important reason as to why they had not joined, followed by in descending order of importance: prefer to make own arrangements for irrigation, able to obtain water without payment, unable to trust other local farmers, and lack of time. 61% of non-members regarded lack of relevant information as being the most important factor or of major importance. Non-members with small farms were particularly likely to cite lack of relevant information as the most important factor in explaining their decision not to join.

Members assessed their degree of satisfaction with their WC, on a five point Likert scale where 1 equals 'very dissatisfied' and 5 equals 'very satisfied' (Figure 1). Only 2.5% were 'very dissatisfied' with the majority being either 'indifferent' or 'satisfied'. Only 3.8% were 'very satisfied'. By this measure, therefore, the introduction of WCs has been neither an unqualified success nor resounding failure.

The average cost of irrigation water for members of WCs in 2004 was 7,845 MKD per ha. The specific figures, as reported by farmers, for flood irrigation of rice, furrow irrigation of maize and furrow irrigation of horticultural crops were 9,556 MKD, 7491 MKD and 7,845 MKD per ha respectively. The cost of flood irrigation of rice and furrow irrigation of maize was higher in 2004 than prior to the formation of the WCs (2001) but the price for irrigating horticultural crops fell slightly. Overall the changes in costs are modest and this may explain why a large proportion of respondents are 'indifferent' to the WCs as evidenced

in Figure 1. The introduction of the WCs failed to lead to substantial reductions in farmers' costs, as envisaged by the World Bank (1997) because of an increase in the base price of water levied by PWEs and greater maintenance costs than initially envisaged

Regarding cost recovery, results are more positive. For the first two years following formation of the WCs average cost recovery rates, measured as the percentage of billed amounts actually paid, were 72 and 70.6% respectively. This compares favourably to the comparable figure of 36% prior to formation. While higher than prior to the formation of WCs, cost recovery nevertheless remained below the World Bank's initial target of 80% and significant non-payment persists.

The data presented in Figure 1 however mask significant differences between WCs. Assessing mean satisfaction scores by WC, based on the five point Likert scale where 1 equals 'very dissatisfied' and 5 equals 'very satisfied', reveals significant variations. Overall farmers in Trkanje WC register the highest mean level of satisfaction (3.75) with the lowest scores for Istibanja (2.89) and Vidovište (2.93). An analysis of variance (ANOVA) indicates the differences between the six WCs are significant at the 5% level ( $F$  test = 2.87). Even with a common external framework significant variations in the performance of WCs are, thus, evident, suggesting the importance of variations in internal characteristics for explaining variations in satisfaction. These factors are explored in the econometric analysis.

#### *Econometric Analysis*

Tables 3, 4 and 5 summarize the results for the estimated models. According to the different diagnosis tests performed all estimated model specifications show a statistical significance at a satisfactory level and no severe signs of misspecification (see different model quality measures). These conclusions are supported by the bootstrapped bias-corrected standard errors as well as the robust estimation technique applied for the Heckman selection specification which confirms the robustness of the various estimates.

The linear hypotheses tests conducted with respect to the significance of explanatory variables indicate for Model 1 (binary probit and ordered probit) the relevance of socioeconomic characteristics, farmers' attitudes towards their water community's structure and conduct, utilised irrigation technology, and for Model 2 (non-parametric least-absolute deviations estimation), in addition, water community cost related characteristics. Considering the specific variables included in Model 1, it is apparent regarding the impact of household characteristics on propensity to join a WC, only farm size is significant (Table 3). For reasons of space, we focus on the most significant findings.

Membership is not biased to a particular demographic group or related to years in education. This suggests that WCs have not been captured by certain elites, at least in terms of the membership base, albeit larger farmers are more likely to become members.

Farmers' attitudes regarding the structure and conduct of their WC were measured via 5 point Likert scales, ranging from 1 'strongly disagree' to 5 'strongly agree' (see Appendix 1). Scale items were designed to measure farmers' trust in the WC and its senior managers, drawing on verified scale items developed by Doney and Cannon (1997). The Likert scales also captured the level of farmers' previous experience with local associations, degree of free riding, effective sanctions for opportunistic behaviour and commitment to the WC. The majority of these scale items are significant; propensity to join a WC is positively related to the WC having transparent resource use, clear geographical area, trust in the management board, effective systems of payment and transparent management structure. Good governance and accountability are thus vital to encouraging farmers to become members. Propensity to join a WC is negatively related to previous involvement with local associations, which reflects past problems and how 'association' is often perceived as being linked to the farm structures of the socialist era.

Considering irrigation technology, farmers for whom a higher proportion of their total farm is irrigated and those using flooding technology (for rice) are more likely to join a WC. This suggests that commitment to WCs is higher where irrigation is more critical to the farm, as expected by Marshall (2004) and Araral (2009).

Table 4 presents the second stage of the Heckman Selection model concerning farmers' satisfaction with their membership. Membership satisfaction is related to household characteristics, the WC's conduct and performance and the technology employed in the case of flood irrigation. Regarding household characteristics, satisfaction is positively related to size of farm and level of education. It appears that better educated people more readily perceived the potential benefits of WC membership and, more importantly, were aware that benefits would accrue over time. Less educated respondents expected all the benefits to be immediate and were impatient for an improvement in their fortunes. This mirrors a finding of Huang *et al.* (2009) for northern China.

Significant, negative correlations between satisfaction and age, and proportion of household income derived from crops are evident. The latter may reflect that those who are more dependent on crops have higher requirements and demands for the WC. This may also explain the significant, negative coefficient for "irrigation is very important for my livelihood". Regarding other Likert scale items, members' satisfaction is positively related to trust in both the leader and management board of the WC, presence of a transparent management structure and structure for conflict solution. These relationships again highlight the importance of good governance, much of which rests with trust of the senior managers of each WC. For instance, the satisfaction of members in one WC plummeted after the community's president allegedly damaged an irrigation channel and refused to pay for repairs. In another case, members withheld payments after they believed that their president had failed to pay his own water bill.



The only significant relationship identified between irrigation type and members' satisfaction is a negative one for flood technology. Implementing effective sanctions to punish non-payers is more difficult in the case of flood irrigation in Macedonia as water typically flows freely between the plots of paying and non-paying farmers. Cutting supplies of water to non-payers would negatively impact on farmers who have paid their bills. This is also reflected in the positive correlation between cost recovery of the WC and membership satisfaction. Flood irrigation, because it demands greater quantities of water, is also more costly per hectare.

A positive correlation is apparent between membership satisfaction and increases in a farmer's water bills between the years 2002 and 2004. The latter variable can, in this case, be considered a proxy for a growth in the size of land under WC irrigation. It is recognized that this is an imperfect measure, and in cases where water costs are unstable would prove unreliable, but given the stability in water prices over the period 2002-4, it does capture principally changes in irrigated farm area. Individuals who expanded their irrigated activities are thus more satisfied, suggesting that structural change is likely to help reinforce the WCs. Finally regarding membership satisfaction, the inverse mill's ratio is significant.

Table 5 presents the results of Model 2, concerning the determinants of changes in farmers' payment behaviour. This analysis is critical to assessing the viability of WCs, given historically very low levels of cost recovery and the objective of WCs becoming financially sustainable local institutions. Significant relationships are uncovered between household characteristics, farmers' attitudes, WC characteristics and payment behaviour. Improvements in payment behaviour (measured in terms of the proportional change over the years 2002 to 2004 in the amount billed for water actually paid by the farmer) are associated with a higher dependence on crops. Those less dependent on irrigation have been less responsive to the WCs in terms of improving their payment behaviour and this may reflect that the sanction of

withholding water is less severe to those not engaged in crop production. This illustrates the importance of salience (Araral, 2009).

Improvements in payment behaviour are positively related to members' satisfaction (2<sup>nd</sup> stage of Model 1) and the presence of effective sanctions for non-paying farmers. Improvements in payment behaviour thus depend on the presence of both a *carrot* (better service delivering higher satisfaction) and *stick* against opportunistic behaviour. The results thus concur with service quality models that assume satisfaction is a critical determinant of payment / purchasing behaviour and the belief that for a CPR, effective sanctions to prevent free-riding also matter.

The coefficient for costs per hectare of land irrigated is significant and negative, indicating that lower fees are associated with improvements in payment behaviour. Older farmers have been significantly less responsive. The latter finding echoes that of Mwangi (2007) regarding common pasture lands.

## **6. Conclusions**

We investigated the performance of WCs as a form of self managing organisation for managing irrigation systems in Macedonia drawing on extensive primary survey data. Studying WCs created under a common legislative framework and operating within a common market for crops, allows for the evaluation of the importance of four categories of internal factors (socio-economic characteristics, structure and conduct of WCs, irrigation technology and costs) in explaining farmers' decision to join a WC and variations in membership satisfaction and payment behaviour. The majority of farmers in project areas have joined a WC, less than 20% are either dissatisfied or very dissatisfied with their WC and the water reform has stimulated a significant increase in cost recovery rates. However, few farmers are very satisfied and the cost of irrigation water for farmers changed little. The

performance of WCs varies considerably. Econometric analysis explored the determinants of WC membership, farmers' satisfaction and payment behaviour. In the remainder of the paper we evaluate the implications for IMT of variables identified as significant.

Regarding socio-economic characteristics, farmers with smaller farms are significantly less likely to join a WC and, if they do become a member, be less satisfied. Non-membership is linked principally to a lack of relevant information, rather than a specific decision to stay outside of the WC. However, providing information regarding an IMT initiative to all farmers in cases like Macedonia, characterised by a mass of small-scale operators and an absence of agricultural census data, would prove difficult.

As Araral (2009) notes, salience matters: within WCs, those with larger cropping areas and greater dependence on irrigation are more committed. The payment behaviour of farmers with a greater dependence on irrigation and who are expanding their farms has also been better. Survey evidence for Macedonia (Noev *et al.*, 2004) suggests that structural change in farming is similar to that in other parts of CEE: consolidation is occurring, with older, less educated farmers and those with smaller land areas more likely to rent out land / exit the sector completely. As older, less educated farmers and those with smaller farms are less satisfied with the WCs, and older farmers have poorer payment behaviour, structural change is likely to be conducive to the establishment of WCs. Structural change should promote salience.

However, structural change alone will not guarantee the success of IMT; the internal structure and conduct of WUAs is also highly significant. In particular, the presence of good governance and accountability contribute to the decision to join, membership satisfaction and changes in payment rates. Analysis reveals that good governance requires effective leadership, transparency in resource allocation and trust in senior managers. While the constitutions of each WUA can detail responsibilities and procedures to help maximise

transparency and promote accountability, much will rest on local factors. Outcomes cannot be fully controlled by policymakers overseeing IMT and the importance of trusted, community minded individuals at the local level cannot be discounted. In acknowledging this, the proponents of IMT cannot guarantee that sustainable WUAs will always emerge – much depends on local social capital, which varies spatially and temporally. The Macedonian case highlights how good governance and accountability are not uniform even within a common legal framework, and dissatisfaction with WCs, where present, has stemmed from both a lack of trust in senior management and an inability to exclude non-payers. While trust is identified as being significant, it cannot be instantly created or transferred.

Cost recovery improved dramatically after the introduction of the WCs. Model 2 reveals that improved payment behaviour depends on, amongst other variables, both the positive satisfaction of members and effective sanctions against non-payers. Previous IMT studies pay little attention to membership satisfaction, yet our analysis indicates that it is a critical determinant of payment behaviour and hence the long-run viability of WUAs. WUAs are unlikely to work where the service to farmers is poor and unreliable. In assessing whether WUAs can be usefully introduced, policy makers therefore should consider if they can deliver both the *carrot* of a reliable service and *stick* of sanctions against opportunistic behaviour. While this is often treated as an ideological debate concerning the merits of state versus alternative management regimes, with a consequent focus on the external environment (respect for private property rights, markets etc.) in shaping outcomes, our analysis reveals that local, internal factors are significant in determining the actual size of carrots and sticks faced by farmers. Consequently, even if WUAs have been successfully introduced in one location, it does not follow that the same rules and procedures transferred to another location will generate comparable results.

Finally, in the Macedonian case, satisfaction is also significantly lower where flood irrigation is employed, for which the costs are higher and depriving non-payers of water is more difficult. This suggests that the success of IMT also depends on the nature of the irrigation technology, with certain systems being more conducive to establishing viable WUAs than others.

## References

- Aggarwal, R.M. (2000). Possibilities and limitations to cooperation in small groups: The case of group-owned wells in Southern India, *World Development*, 28(8), 1481-1497.
- Arabmazar, A., and Schmidt, P. (1981). Further Evidence on the Robustness of the Tobit Estimator to Heteroscedasticity, *Journal of Econometrics*, 17(2), 253-258.
- Araral, E. (2005a). Water user associations and irrigation management transfer: understanding impacts and challenges. In: P. Shyamsunder, E. Araral and S. Weeraratne (eds.), *Devolution of Resource Rights, Poverty and Natural Resource Management*, World Bank Environmental Economics Series, Paper No.104, pp.45-63.
- Araral, E. (2005b). Bureaucratic incentives, foreign aid and path dependence. *Policy Sciences*, 38, 131–157.
- Araral, E. (2009). What Explains Collective Action in the Commons? Theory and Evidence from the Philippines, *World Development*, 37(3), 687-697.
- Baland, J.-M., and Platteau, J-P. (1996). *Halting Degradation of Natural Resources. Is There a Role for Rural Communities?* Oxford: Clarendon Press.
- Bardhan, P. (1993). Analytics of the Institutions of Informal Cooperation in Rural Development, *World Development*, 21(4), 633-639.
- Bromley, D. W. (1992). The Commons, Common Property, and Environmental Policy, *Environmental and Resource Economics*, 2(1), 1–17.

- Cronin, J.J. and Taylor, S.A. (1992). Measuring service quality: a re-examination and extension, *Journal of Marketing*, 56(3), 55-68.
- Doney, P. M. and Cannon, J.P. (1997). An examination of the nature of trust in buyer-seller relationships, *Journal of Marketing*, 61(2), 35-51.
- Easter, K.W. (2000). Asia's irrigation management in transition: a paradigm shift faces high transaction costs, *Review of Agricultural Economics*, 22(2), 370–388.
- Efron, B., R. J. Tibshirani (1993). *An Introduction to the Bootstrap*. London: Chapman & Hall.
- Greene, W. (2003). *Econometric Analysis* 5<sup>th</sup> ed. Prentice Hall, Upper Saddle River, New Jersey, USA.
- Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. *Econometrica* 47(1): 153-161.
- Horowitz, J. L. (2001). The Bootstrap. In: Heckman, J. J. and E. Leamer (eds.). *Handbook of Econometrics*, Vol. 5, Amsterdam: North-Holland, pp.3159 – 3228,.
- Huang, Q., Rozelle, S., Wang, J. and Huang, J. (2009). Water management institutional reform: representative look at northern China, *Agricultural Water Management*, 96(2), 215-225.
- Huber, P. J. (1967). The behavior of maximum likelihood estimates under nonstandard conditions. In *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley, CA: University of California Press, vol. 1, 221–223.
- IWMI (2003). *How to Establish a Water Users Association: practical steps for social mobilizers*, International Water Management Institute, Tashkent, mimeo.
- Johnson, S.H. (1995). Selected experiences with irrigation management transfer: economic implications, *International Journal of Water Resources Development*, 11(1), 61-72.
- Jonston, J. and Di Nardo, J. (1997). *Econometric Methods*, 4<sup>th</sup> ed. New York: McGraw-Hill.

- Kloezen, W.H. (2002). Accounting for water: institutional viability and impacts of market-oriented irrigation interventions in Central Mexico, University of Wageningen, unpublished PhD thesis.
- Lam, W.F. (1998). *Governing Irrigation Systems in Nepal: Institutions, Infrastructure, and Collective Action*, Oakland, CA: ICS Press.
- Macours K. and Swinnen, J.F.M. (2002). Patterns of Agrarian Transition, *Economic Development and Cultural Change*, 50(2), 365-395.
- Maddala, G.S. (1998). *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press. Cambridge, UK.
- Marshall, G.R. (2004). Farmers cooperating in the commons? A study of collective action in salinity management, *Ecological Economics*, 51(3-4), 271-286.
- Meinzen-Dick, R., Mendoza, M., Sadoulet, L., Abiad-Shields, G. and Subramanian, A. (1997). *Sustainable Water User Associations: Lessons from a literature review*. Washington, D.C.: The World Bank. Technical Paper 354.
- Meinzen-Dick, R., (2007). Beyond panaceas in water institutions, *PNAS*, 104(39), pp.15200-15205.
- Merrey, D.J., and Murray-Rust, D.H (1991). Peoples' Participation in the Gal Oya Rehabilitation Project as Viewed by Agency Personnel. In K.K. Singh (ed.), *Farmers in the Management of Irrigation Systems*. New Delhi: Sterling Publishers, pp.121-146.
- Mwangi, E. (2007). Subdividing the commons: distributional conflict in the transition from collective to individual property rights in Kenya's Maasailand, *World Development*, 35(5), 815-834.
- Noev, N., Swinnen, J.F.M. and Vranken, L. (2004). Development of Land Rental Markets in Bulgaria and the Former Yugoslav Republic of Macedonia, Research Group on Food

- Policy, Transition, and Development, Katholieke Universiteit Leuven, Working Paper 2004/1.
- Oorthuizen, J. and Kloezen, W.H. (1995). The other side of the coin: A case study on the impact of financial autonomy on irrigation management performance in the Philippines. *Irrigation and Drainage Systems*, 9(1):15-37.
- Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, New York.
- Ostrom, E. (1992). *Crafting Institutions for Self-Governing Irrigation Systems*. Institute for Contemporary Studies Press, San Francisco.
- Ostrom, E., and Gardner, R. (1993). Coping with Asymmetries in the Commons: self-governing irrigation systems can work. *Journal of Economic Perspectives* 7(4), 93–112.
- Paarsch, H. (1984). A Monte Carlo Comparison of Estimators for Censored Regression Models. *Journal of Econometrics*. 24,197 – 213.
- Peshevski, M., Boshev, D., Shekerinov, D. (2006). Management of water resources in transition period in Republic of Macedonia with special regard to hydromeliorative system (HMS) Bregalnica. *Ekonomika Poljoprivrede*, 3-4, 81-94.
- Powell, J.L. (1984). Least Absolute Deviations Estimation for the Censored Regression Model. *Journal of Econometrics*, 25, 303-325.
- Powell, J.L. (1986). Censored Regression Quantiles. *Journal of Econometrics*, 32, 143-155.
- Rogers, W. (1993). Calculation of Quantile Regression Standard Errors. *Stata Technical Bulletin*. 13, 18-19.
- Shah, T., Molden, D., Sakthivadivel, R. and Seckler, D. (2000). The Global Groundwater Situation: Overview of Opportunities and Challenges. Colombo, Sri Lanka: International Water Management Institute.



- Svendsen M. and Murray-Rust, H. (2001). Creating and consolidating locally managed irrigation in Turkey: the national perspective. *Irrigation and Drainage Systems*, 15(4): 355–371.
- Tang S. Y. (1992). *Institutions and Collective Action: Self-governance in Irrigation*, San Francisco: Institute for Contemporary Studies Press
- Taseva J. (2000). *Irrigation Sector in Macedonia*. Ministry of Agriculture, Forestry and Water Economy, Skopje, mimeo.
- Taseva, J. (2004). Macedonia's experience with irrigation reform. Ministry of Agriculture, Forestry and Water Economy, Skopje, mimeo.
- Ternström, I. (2002). Incentives or Coordination? Cooperation in Irrigation Systems in Nepal, Ph.D. Thesis in Economics, Stockholm School of Economics, Sweden.
- Theesfeld, I. (2004). Constraints on collective action in a transitional economy: the case of Bulgaria's irrigation sector, *World Development*, 32(2), 251-271.
- Vandersypen, K., Keita, A., Kaloga, K., Coulibaly, Y., Raes, D., Jamin, J-Y., (2006). Sustainability of farmers' organization of water management in the Office du Niger irrigation scheme in Mali, *Irrigation and Drainage*, 55(1), 51-60.
- Vermillion, D.L. and Sagardoy, J.A. (1999). Transfer of Irrigation Management Services: Guidelines. Rome: FAO Irrigation and Drainage Paper 58.
- Vijverberg, W. (1987). Non-Normality as Distributional Misspecification in Single-Equation Limited Dependent Variable Models, *Oxford Bulletin of Economics and Statistics*. 49(4), 417 – 430.
- Wade, R. (1988) *Village Republics: Economic Conditions for Collective Action in South India*, Cambridge, UK: Cambridge University Press.
- White, H. (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48(4), 817-838.

- World Bank (1997). FYROM: Irrigation Rehabilitation and Restructuring Project: Staff Appraisal Report, Report No. 17013 MK.
- World Bank (2006). Agriculture and EU Accession: Achieving FYR Macedonia's Agricultural Potential, Report No. AAA11-MK.
- Yercan, M. (2003). Management turning-over and participatory management of irrigation schemes: a case study of the Gediz river basin in Turkey, *Agricultural Water Management*, 62(3), 205-214.
- Yercan, M., Dorsan, F. and Ul, M.A. (2004). Comparative analysis of performance criteria in irrigation schemes: a case study of Gediz river basin in Turkey, *Agricultural Water Management*, 66(3), 259-266.
- Zhovtonog, O., Dirksen, W. and Roest, K. (2005). Comparative assessment of irrigation sector reforms in Central and Eastern European countries of transition, *Irrigation and Drainage*, 54(5), 487-500.

**Table 1: Factors potentially influencing the probability of successful self-management in irrigation**

Category	Sub-category	Specific variables / proxies
External environment		Legal rights to organise and negotiate, property rights, markets for crops
Internal factors	Socio-economic characteristics	Water scarcity and impact of irrigation on incomes, farm size, age and education of farmer
	Structure and conduct of the WUA	Number of members, past experience of co-operation, effective leadership, sanctions against opportunistic behaviour
	Irrigation Technology	Type of irrigation (flood, sprinkler etc.)
	Cost related factors	Irrigation costs per hectare, cost recovery of WUA

Source: own construction

**Table 2: Timeline charting the development of WUAs in Macedonia**

Year	Event
1998	New Water Law and project for rehabilitation of irrigation, co-financed by the World Bank, agreed
1999	Work on repairs to the Kalimanci dam and rehabilitation of main canals in Bregalnica commence
2002	Protocol for transferring irrigation management duties to Water User Co-operatives signed First 6 WCs established (Istibanja, Orizari, Trkanje, Vidovište, Obleševo and Zrnovci)
2003	Water User Law passed. Water User Co-operatives renamed Water Communities.
2005	By May 2005: 25 WCs established in Bregalnica region
2007	World Bank co-financed project ended

**Table 3: Stage 1 of Heckman Selection Model – Bootstrapped Binary Probit Estimates**

Independents	coefficient <sup>1</sup>	robust z-value	bootstrapped bias-corrected standard error 95% confidence interval <sup>2</sup>
<i>stage 1 – selection equation</i>	<i>dependent 1: water community membership</i>		
<i>Socio-economic characteristics</i>			
Hectares farmed	0.467**	2.17	[0.210; 0.221]
Proportion of land used for crops	-0.042	-0.62	[0.066; 0.069]
Proportion of household income derived from farming	-0.017	0.48	[-0.035; -0.036]
Proportion of household income derived from crops	-0.001	0.956	[-0.001; -0.001]
Age of farmer	0.204	0.620	[0.321; 0.337]
Level of education	-0.158	0.701	[-0.220; -0.231]
<i>Farmers attitudes towards water community's structure and conduct</i>			
Water communities improve the quality of irrigation	-0.011	0.986	[-0.011; -0.011]
WC guarantees transparent resource use	1.199***	2.54	[0.460; 0.484]
WC covers a clear geographical area	1.201***	2.72	[0.431; 0.453]
Irrigation is very important for livelihood	0.266	0.43	[0.603; 0.634]
Farmers have common view on irrigation management	-0.768***	-2.59	[0.289; 0.304]
Farmers maintain irrigation equipment for long-run use	-0.686*	-1.63	[0.410; 0.431]
Farmers consider only their short-term interest	0.067***	2.70	[0.024; 0.025]
Want to have a say in how irrigation water is delivered	1.515***	3.39	[0.436; 0.458]
Want to have a say in how irrigation equipment is maintained	-0.144	-0.29	[0.484; 0.509]
Trust in the leader of the WC	0.059	0.14	[0.411; 0.432]
Trust in the management board of the WC	1.679***	3.79	[0.432; 0.454]
Experience with involvement in local associations	-1.739***	-3.72	[0.456; 0.479]
Transparent management structure	1.037***	2.89	[0.350; 0.368]
Transparent relations between WC and water authority	-0.012	-0.02	[0.585; 0.615]
Easy to cut access to non-payers	0.779***	3.28	[0.232; 0.243]
Use of irrigation water can be effectively monitored	-0.632**	-2.16	[0.285; 0.300]
Transparent structure for conflict solution	0.343	1.11	[0.301; 0.317]
<i>Irrigation technology related characteristics</i>			
Proportion of total farm area irrigated	2.131***	3.05	[0.681; 0.716]
Proportion of total farm area irrigated by sprinkler technology	1.276	1.37	[0.908; 0.955]
Proportion of total farm area irrigated by flooding technology	1.696***	2.61	[0.634; 0.666]
constant	-0.654	-0.08	[7.971; 8.379]
<i>log pseudo-LL</i>	<i>-19.114</i>		
<i>Wald test of model significance, <math>\chi^2(26)</math></i>	<i>91.00***</i>		
<i>McFadden's R<sup>2</sup></i>	<i>0.671</i>		
<i>McKelvey/Zavoina's R<sup>2</sup></i>	<i>0.899</i>		
<i>Cragg &amp; Uhler's R<sup>2</sup></i>	<i>0.741</i>		
<i>Count R<sup>2</sup> (adj Count R<sup>2</sup>)</i>	<i>0.955 (0.556)</i>		
<i>linear hypotheses tests on model specification (<math>\chi^2(x)</math>)</i>			
<i>H<sub>0</sub>: socio-economic characteristics related variables have no significant effect (<math>\chi^2(6)</math>)</i>			<i>46.40*** (rejected)</i>
<i>H<sub>0</sub>: farmer's attitudes/experiences related variables have no significant effect (<math>\chi^2(17)</math>)</i>			<i>46.30*** (rejected)</i>
<i>H<sub>0</sub>: irrigation technology related variables have no significant effect (<math>\chi^2(3)</math>)</i>			<i>19.97*** (rejected)</i>

1: \* - 10%-, \*\* - 5%-, \*\*\* - 1%-level of significance; 2: 1000 replications.

**Table 4: Stage 2 of Heckman Selection Model – Bootstrapped Ordered Probit Estimates**

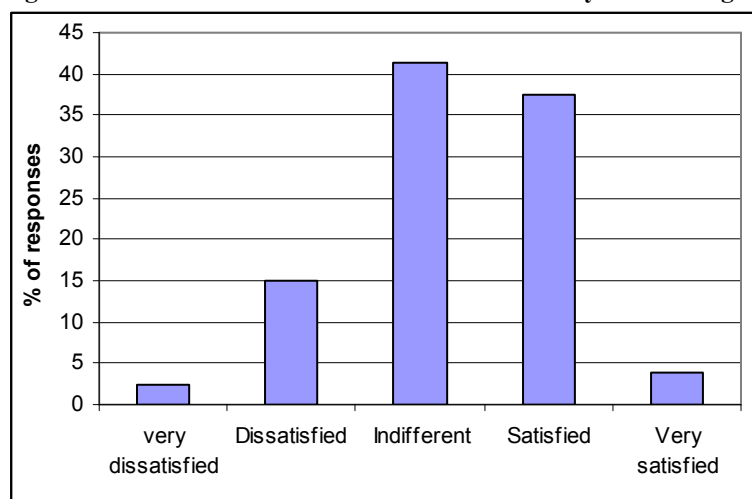
n=176	coefficient <sup>1</sup>	robust z-value	bootstrapped bias-corrected standard error 95% confidence interval <sup>2</sup>
Independents			
<i>stage 2 – outcome equation</i>	<i>dependent 2: farmer’s satisfaction with water community membership</i>		
<i>Socio-economic characteristics</i>			
Hectares farmed	0.946**	2.15	[0.113; 0.120]
Proportion of land used for crops	-0.003	-0.19	[0.013; 0.021]
Proportion of household income derived from farming	-0.001	-0.15	[0.011; 0.009]
Proportion of household income derived from crops	-0.013***	-2.70	[0.005; 0.006]
Age of farmer	-0.273**	-2.04	[0.129; 0.130]
Level of education	0.360***	2.79	[0.124; 0.128]
<i>Farmers’ attitudes towards water community’s structure and conduct</i>			
WC guarantees transparent resource use	0.019	0.11	[0.164; 0.178]
Irrigation is very important for livelihood	-0.489***	-3.16	[0.183; 0.223]
Want to have a say in how irrigation water is delivered	-0.249	-1.09	[0.218; 0.221]
Want to have a say in how irrigation equipment is maintained	0.091	0.51	[0.169; 0.174]
Trust in the leader of the WC	0.478***	2.71	[0.171; 0.175]
Trust in the management board of the WC	1.089***	5.07	[0.207; 0.208]
Experience with involvement in local associations	0.363***	2.09	[0.159; 0.167]
Transparent management structure	0.885***	4.49	[0.181; 0.182]
Transparent relations between WC and water authority	0.118	0.65	[0.159; 0.164]
Transparent structure for conflict solution	0.269***	11.24	[0.216; 0.236]
<i>Irrigation technology related characteristics</i>			
Proportion of total farm area irrigated	-0.165	-0.43	[0.399; 0.413]
Proportion of total farm area irrigated by furrow technology	0.123	0.27	[0.376; 0.446]
Proportion of total farm area irrigated by sprinkler technology	0.059	0.18	[0.313; 0.322]
Proportion of total farm area irrigated by flooding technology	-0.828***	-2.27	[0.429; 0.448]
<i>Water community cost related characteristics</i>			
Cost recovery	0.297***	11.17	[0.023; 0.027]
Costs per hectare of land irrigated	0.002***	2.15	[7.88e-05; 8.78e-05]
Increase in water bill 2002 to 2004	0.001***	2.08	[5.46E-05; 6.91E-05]
<i>inverse mill’s ratio</i>	-2.123***	-2.51	[0.698; 0.881]
<i>log pseudo-LL</i>	-97.911		
<i>Wald test of model significance, <math>\chi^2(24)</math></i>	96.78***		
<i>McFadden’s R<sup>2</sup></i>	0.620		
<i>McKelvey/Zavoina’s R<sup>2</sup></i>	0.537		
<i>Cragg &amp; Uhler’s R<sup>2</sup></i>	0.503		
<i>Count R2 (adj Count R2)</i>	0.946 (0.640)		
<i>linear hypotheses tests on model specification (<math>\chi^2(x)</math>)</i>			
<i>H<sub>0</sub>: socio-economic characteristic related variables have no significant effect (<math>\chi^2(6)</math>)</i>			18.12*** (rejected)
<i>H<sub>0</sub>: farmer’s attitudes/experiences related variables have no significant effect (<math>\chi^2(9)</math>)</i>			29.48*** (rejected)
<i>H<sub>0</sub>: irrigation technology related variables have no significant effect (<math>\chi^2(4)</math>)</i>			53.60*** (rejected)
<i>H<sub>0</sub>: water community cost related variables have no significant effect (<math>\chi^2(3)</math>)</i>			12.20*** (rejected)

1: \* - 10%-, \*\* - 5%-, \*\*\* - 1%-level of significance; 2: 1000 replications.

**Table 5: Non-Parametric Cumulative Least Absolute Deviation Model – Bootstrapped Estimates**

n=176	coefficient <sup>1</sup>	t-value	bootstrapped bias-corrected standard error 95% confidence interval <sup>2</sup>
<i>dependent</i> : proportional change in farms' water bill payment 2002 - 2004			
<i>independents</i>			
<i>Socio-economic characteristics</i>			
Hectares farmed	-0.908	-0.94	[0.942; 0.990]
Proportion of land used for crops	0.437***	5.44	[0.078; 0.082]
Proportion of household income derived from farming	-0.447***	-8.28	[0.053; 0.055]
Proportion of household income derived from crops	0.433***	9.55	[0.044; 0.046]
Age of farmer	-0.608***	-0.56	[1.059; 1.113]
Level of education	0.938	0.88	[1.039; 1.093]
<i>Farmers attitudes towards water community's structure and conduct</i>			
Farmer's satisfaction with water community membership ( $\hat{y}$ hat model 2)	3.571***	3.25	[1.098; 1.071]
Easy to cut access to non-payers	4.147**	2.02	[2.053; 2.002]
<i>Water community cost related characteristics</i>			
Membership	-3.908	-0.85	[4.597; 4.483]
Costs per hectare of land irrigated	-0.003***	-6.02	[4.98E-04; 4.86E-04]
Increase in water bill 2002 to 2004	0.004***	13.71	[2.92E-04; 2.84E-04]
<i>Irrigation technology related characteristics</i>			
proportion of total farm area irrigated	-2.776	-0.78	[3.559; 3.470]
<i>constant</i>	-17.411	-1.44	[12.091; 11.789]
<i>minimum sum of deviations</i>	2966.997		
<i>Adj. McFadden's R2</i>	0.878		
<i>linear hypotheses tests on model specification (<math>\chi^2(x)</math>)</i>			
$H_0$ : socio-economic characteristics related variables have no significant effect ( $\chi^2(6)$ )			20.96*** (rejected)
$H_0$ : farmer's attitudes/experiences related variables have no significant effect ( $\chi^2(3)$ )			4.76*** (rejected)
$H_0$ : water community cost related variables have no significant effect ( $\chi^2(3)$ )			84.05*** (rejected)

**Figure 1: Overall satisfaction with water community for the original six WCs**



Source: survey data

## Appendix 1: Descriptive Statistics

Variable	Description	Mean	StDev.
<i>Dependent variables</i>			
Membership of WC	1= member, 0 = non-member	0.90	0.31
Satis (farmers' satisfaction with WC membership)	5 point Likert scale. (1= very dissatisfied, 4 = dissatisfied, 3=indifferent, 4= satisfied, 5= very satisfied)	3.42	0.90
Payincr	% change in amount of total water bill paid by the farmer (2002-2004)	-7.22	39.39
<i>Independent variables</i>			
<i>Socio-economic characteristics</i>			
Hectares farmed	In ha	5.61	20.63
Proportion of land used for crops	In %	98.41	6.29
Proportion of household income derived from farming	In %	67.11	24.41
Proportion of household income derived from crops	In %	62.77	27.80
Age of farmer	In years		
Level of education	Highest achieved: 1= primary education, 2=high school without graduation, 3= high school, 4= university graduation, 5=post-graduate	3.45	0.71
<i>Structure and Conduct of WC</i>			
WC guarantees transparent resource use	5 point Likert scale, regarding agreement with statement for local WC. (1=strongly disagree, 4 = disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree)	3.64	0.96
WC covers a clear geographical area	5 point Likert scale, as above	3.96	0.90
Irrigation is very important for my livelihood	5 point Likert scale, as above	4.55	0.80
Farmers have a common view on irrigation management	5 point Likert scale, as above	3.55	1.00
Farmers maintain irrigation equipment for long run use	5 point Likert scale, as above	3.88	1.01
Farmers only consider their short-term interest	5 point Likert scale, as above	2.99	1.19
Want to have say how irrigation water delivered	5 point Likert scale, as above	3.55	0.92
Want to have a say in how irrigation equipment maintained	5 point Likert scale, as above	3.50	0.98
Trust in leader of WC	5 point Likert scale, as above	3.19	1.21
Trust in the management board of the WC	5 point Likert scale, as above	3.28	1.05
Experience with involvement in local associations	5 point Likert scale, as above	3.14	1.15
Transparent management structure	5 point Likert scale, as above	3.40	1.04
Transparent relations between WC and water authority	5 point Likert scale, as above	3.21	0.97
Easy to cut access to non-payers	5 point Likert scale, as above	3.50	1.09
Use of irrigation water effectively monitored	5 point Likert scale, as above	3.35	1.02
Transparent structure for conflict resolution	5 point Likert scale, as above	3.50	0.84
<i>Irrigation technology related characteristics</i>			
Proportion of total farm area irrigated	In %	59.13	0.65
Proportion of total farm area irrigated by flood	In %	20.90	0.25
<i>Cost related characteristics</i>			
Cost recovery of WC	% of total billed amount paid	79.10	8.69
Cost per hectare of land irrigated, 2004	Macedonian Denar (MKD) per ha	7640.21	5642.96
Change in water bill 2002 to 2004	Macedonian Denar (MKD)	-170.28	9870.85

## Appendix 2 - Bootstrapping

If we suppose that  $\hat{\Psi}_n$  is an estimator of the parameter vector  $\psi_n$  including all parameters obtained by estimating [1] and [2] based on our original sample of 176 observations, then we are able to approximate the statistical properties of  $\hat{\Psi}_n$  by studying a sample of  $C = 1,000$  bootstrap estimators  $\hat{\Psi}_n(c)_m, c = 1, \dots, C$ . These are obtained by re-sampling our observations respectively – with replacement – and re-computing  $\hat{\Psi}_n$  by using each generated sample. Finally, the sampling characteristics of our vector of parameters are obtained from:

$$\hat{\Psi} = \left[ \hat{\Psi}_{(1)m}, \dots, \hat{\Psi}_{(1000)m} \right] \quad [A1]$$

As discussed extensively by Horowitz (2001) and Efron and Tibshirani (1993), the bias of the bootstrap as an estimator of  $\hat{\Psi}_n$ ,  $B_{\tilde{\psi}} = \tilde{\Psi}_n - \hat{\Psi}_n$ , is itself a feasible estimator of the bias of the asymptotic estimator of the true population parameter  $\psi_n$ . Hence the bias-corrected estimator of  $\psi_n$  can be computed by  $\hat{\psi}_n - B_{\tilde{\psi}} = 2\hat{\psi} - \tilde{\psi}$ . This holds also for the standard deviation of the bootstrapped empirical distribution, providing a natural estimator of the standard error for each initial parameter estimate. By using a bias corrected bootstrap we aim to reduce the likely small sample bias in the initial estimates.

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<sup>1</sup> The Bregalnica irrigation system includes a delivery network of 26,008 km in total length (Peshevski *et al.* 2006). The system's water is supplied by the Kalimanci Dam on the Bregalnica River.

<sup>2</sup> Measured as the percentage of the billed amount actually paid by farmers.

<sup>3</sup> Here the estimate is calculated as the product of three matrices: the matrix formed by taking the outer product of the observation-level likelihood/pseudo-likelihood score vectors is used as the middle of these matrices, and this matrix is in turn pre- and post-multiplied by the usual model-based variance matrix (see Greene, 2003).

<sup>4</sup> We utilize the iterative linear programming algorithm (ILPA) contained in STATA.