Estimating transaction costs associated with water policy implementation in South Africa

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Abstract

Water is a complex economic good and requires optimal management to control its rising scarcity and competition for use. South Africa is in the process of implementing market based water policy reforms to attain equity, efficiency, and sustainability. However, these reforms have not been entirely successful and water allocation problems persist. This could be due the associated transaction costs arising from the transition of the policy process among other factors. Previous research lacks to explain the complete interplay of issues. Transaction costs constitute a large component of total policy costs yet remain generally unmeasured. This study identifies and quantifies transaction costs incurred by various stakeholders in the Olifants basin. Further, determinants of irrigation farmers' transaction costs are assessed using regression methods. Results from this study feed back into the water policy process through allowing comparisons between policy alternatives ex ante and evaluation of existing policies ex post for improvement purposes

Keywords: transaction costs, water policy reforms, South Africa, Olifants river basin

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1. Introduction

Implementation of water policy reforms requires a good understanding of the transaction costs that surround and influence water users' behaviours. Transaction costs have been widely identified as the biggest hindrances to policy implementation and compliance as they constitute a large component of total policy costs (Coggan et al, 2010; Howitt, 1998; Easter, 1991). For instance studies carried out in the US show that transaction costs represent a substantial part of total costs incurred in designing a policy objective, with a magnitude ranging from 8% of the water purchase cost to 38% of the agricultural assistance program (Howitt, 1994; McCann et al, 2005). In Latin America, a study carried out in Chile shows that transaction costs associated with water trade represent between 7 and 23% of the total price (Hearn and Eater, 1995). Therefore policymakers should take into account the nature and level of transaction costs in designing policy recommendations, since this influence the extent to which water users for productive purposes (farmers, mines and households) react with regard to the designed policy. Most of the studies on transaction cost analysis have evaluated the role they play in influencing allocation of resource (Coase, 1960, Williamson, 1985; Oates, 1986; Griffin, 1991; Stavins, 1995, North, 1990; Fullerton, 2001, Goulder and Parry, 2008), without saying little about the extent to which they affect policy implementation outcomes. For instance, Coase (1960) and Williamson (1985) have eloquantly elaborated the importance of transaction costs to shape competition between agents and therefore protect investors against risks and uncertainty that arise from market allocation. Very few studies have investigated the impacts of transaction costs on the success or failures of public policy implementation and compliance. This limitation is mainly due to the difficulty to measure and monitor transaction costs, especially in countries where the existing institutional arrangements have difficulty securing property rights allocated to stakeholders.

This present paper contributes to filling this gap in research in showing the extent to which transaction costs influence success (failures) of water policy reforms in South Africa. Based on survey data collected in the Olifants river basin, we identify the main transaction costs associated with water policy reforms in the country and estimate the factors that drive their evolution at farm level. Transaction costs are differentiated between water users and managers in order to take into account the heterogeneity in farm sizes, locations and features of policymakers. Water users, in this study, are represented by irrigation farmers, since they consume more than 80% of the total available water in the Olifants river basin. Managers refer to policymakers from the Department of Water and Sanitation[2] (DWS) who are in charge of desiging and enforcing implementation of water policy reforms in the country. The data collected from the field allow us to evaluate the extent to which farm and management features influence evolution of transaction costs. We follow Coggan et al, (2010) and McCann et al (2005) and consider administration and support, monitoring, contracting and enforcement costs, as typologies of transaction costs. The choice of these typologies is driven by the characteristics of the water and agricultural sectors in the Olifants region and the quality of the data collected at household level.

Five different water policies - included in the National Water Act (1998) and the National Water services (1997) of the country - are considered in this paper: water tariffs, compulsory licensing, water trade between farmers, establishment of water user associations (WUAs) and effluent discharge system that improves water quality standards. In South Africa water tariffs (pricing) are subsidized and fixed at low level to reflect cost of water supply and scarcity in water resources. To reduce costs associated with water supply, municipal infrastructure grants as well as various other temporary conditional capital, grants[3] are provided by the states. Compulsory licensing is a policy, which aims at promoting re-allocation of water resources in water stressed[4] catchments in South Africa in order to address past discriminatory practices encountered during apartheid and to support the rise of emerging farmers. Beyond areas already under water stress, compulsory licensing is also applied to areas where water stress is expected and water quality is damaged by pollution. The water market is a mechanism used in promoting a voluntary transfer of water-use rights for financial compensation (Saleth and Dinar, 2008; Easter et al, 1998; Howitt, 1998;

[2] Previous name was Department of water Affairs. A new institutional change has been operated since 2014 and the department became Department of Water and Sanitation.

[3] The Consolidated Municipal Infrastructure Programme

[4] It is important to highlight that water scarcity (stress) is different from vulnerability in water access. Different indicators (indexes) are provided for a determination of water scarcity (i.e: Falkenmark indicator, Basic Human Water Requirement, Social Water Stress index etc). Brown (2011) provides the panorama of indicators measuring both water stress and water access vulnerability.

Hassan and Thiam, 2015; Rosegrant and Binswanger, 1994). In the agricultural sector water market assumes that farms holding licenses that are not used after a completion of irrigation schedules (surplus license holders) sell such licenses to the ones that still need additional water (deficit license holders) to complement their irrigation schedules (Thiam et al, 2015). No official and formal water market is currently taking place in South Africa. However, evidences have shown that some areas (Orange river and Nkwaleni Valley) experience informal water market, especially with commercial large-scale farmers (Nieuwoudt and Armitage, 2004; Pott et al, 2009). Water user associations (WUAs) are new forms of institutional arrangements set up by the former Department of Water Affairs of the Republic of South Africa to enhance decentralized and involvement of local stakeholders into the water management process. Finally, effluent discharge is a policy undertaken to reduce water pollution, mainly generated by mining industries and large-scale commercial farmers. All these policies have been highlighted in the national water reform and strategy development in the country. The main target of these policies is to improve water allocation and promote an equitable access to water resources by all users regardless of their locations, sizes and historical past. The purpose of this paper is to assess the transaction costs associated with each one of these policies. Our objective is to identify policies that require high (low) transaction costs throughout their implementation, since evidences have shown that a policy that is associated with a lower transaction cost has the advantage of being easily implemented contrary to a policy that involves high transaction costs (McCann et al, 2005; Coggan et al, 2010; 2013). Additionally this paper allows an evaluation of whether transaction costs have contributed to facilitating adoption of some policies (water tariffing and WUAs) instead of the others (water market and compulsory licensing) in the South African water sector. Finally, this paper allows to providing the underlying factors that affect transaction costs in water policy implementation.

We use one of the most stressed catchment in the country, the Olifants river basin, as a case study. The Olifants river basin is usually considered as a hotspot of policy reform implementation and compliance since it covers three main important provinces (Gauteng, Mpumalanga and Limpopo) and has experienced many institutional changes over the past years to facilitate water policy implementation and compliance

(DWA, 2011). Furthermore, this basin is used as example since transaction costs have been identified as the main constraints of policy compliance in a number of farming activities (Walter et al, 2011; Thiam et al, 2015).

We follow the typology and chronology provided in McCann and Easter, (2004) and McCann et al., (2005) to measure the associated transaction costs of the selected water policies. Measurement is carried out under three different policy phases: early implementation, full implementation and established program. Early implementation refers to a situation in which water policy rules are designed and adopted by public services, public agents are hired for admistration and notices and hearings are conducted. During early implementation the policy is at the beginning of its life cycle and the large part of the associated transaction costs is represented in administrative and support costs. Therefore, this first phase corresponds to a situation in which the policy is newly passed by the parliament and the first feedbacks in acceptance from water users is collected by public administrators. Full implementation refers to a situation where policies come into full effect, meaning that the policy is now completely implemented and water users have changed their behaviors to adopt and comply with the terms of the policy (McCann et al, 2005). This part, full implementation, involves mainly contracting and enforcement costs. Finally establishment program corresponds to situations where policy has reached the end of its life cycle and therefore it is entirely integrated as full part of the water decision making investment. That means any decision taken by water users should take into account the requirements of the policy. For instance a policy that aims at changing water pricing should influence the decision of farmers to adopt more water-efficient irrigation technology. At the same time, a policy that aims at improving water quality affects water users and reduces their corresponding demands

The paper is structured as follow. Section 2 provides the theoretical underpins of the linkages between transaction costs and water allocation efficiency. Section 3 outlines the extent to which transaction costs affect water policy reforms in South Africa. Section 4 presents the empirical analysis used to estimate the determinants of transaction costs. The data used in the empirical analysis are described in Section 4.2.

Section 5 presents the results. The last section 6 presents the conclusion of this paper and draws some policy recommendations.

2. Transaction costs and water resources management

Recent developments in natural resources management and policy consider water as an economic good. Therefore, it is important to provide sound policy instruments that improve water management practices, since different sectors (Agriculture, industry, and services) need water to perform economic activities. Transaction costs play a very important role in explaining adoption and compliance (non-adoption) of water policy measures, since they affect market failures that arise from agents' opportunistic behaviors. For instance, a policy associated with high transaction costs usually has a lower likelihood of implementation contrary to a policy that involves low transaction costs. Water policy outcomes and compliance therefore, depend not only on the distortion that arises between the marginal costs of providing the physical and management infrastructure but also the marginal benefits of receiving water resources (Perry et al.,1997). Additionally, it also depends on the associated transactions that surround and influence cost-effectiveness of policy measures (Young, 1986; Garrick and Aylward, 2012; Ofei-Mensah and Bennet, 2013). Figure 1 below illustrates this potential distortion. Water, like many other goods is valuable and users attach a price they are willing to pay for it. Water users increase their consumption as long as the benefits from an additional volume (in m^3) of water used exceed costs incurred in acquiring the resource. The interconnection between marginal costs and marginal benefits provides the optimal consumption level, at point x*. Figure 2 shows the extent to which transaction costs affect water allocation efficiency when transaction costs are considered. It indicates that, if water is given a non-optimal price (either at P^{htc} or P^{ltc}), where the price is different from the marginal costs of supply, water users consume a different amount of x m^3 of water instead of x*. In this case, water users either consume x^{htc} or x^{ltc}. This is not efficient because marginal costs do not equal marginal benefits. The increase (decrease) in costs exceeds the increase (decrease) in benefits and this gives the dead weight loss. The dead weight loss comprises of transaction costs and other externalities in water use (such as deterioration in water quality, mismanagement of irrigation practices, informal water trade settlement etc.). This loss in economic welfare consists of water users who will no longer consume water due to high transaction costs that affect water pricing. Therefore, the effective value of water is above their original willingness to pay. At the same time, the costs of water supply infrastructures are reduced since demand has been reduced and the supplier does not cover the cost of supplying the resource. The benefit that the water suppliers and users would have added to the economy but for transaction costs is a deadweight loss of transaction costs. Therefore, a control over transaction costs affects the equilibrium between supply and demand of water. Anytime a distortion arises, equilibrium is changed and water users should find a new combination of water use and price paid to maximize private benefits. These can be combined with the marginal costs to ensure an optimal price that lead to a more efficient way of water allocation and management practices.

Figure 1: distortion between water supply and demand

Figure 2: water allocation measures with transaction costs

3. Transaction costs and water policy reforms in South Africa

The water sector reform in South Africa offers a very good environment to analize the extent to which transaction costs influence efficiency in water policy. Since the democratization of the country in 1994, different water management initiatives have been introduced in order to improve economic efficiency of water use and promote equity in water allocation between different end-uses (Dinar et al, 2006; WRC, 2008; DWAs, 2010). These policies combine market-based as well as command-and-control instruments and they are embedded within the National Water Act (1998) and the National Water Services (1997), the two regulatory frameworks undertaken in the country to promote a better management of water resources. The regulatory frameworks have created new institutions structures – catchment management areas - CMAs and water user associations - WUAs - that support implementation of these water policies and decentralized and more inclusive water management practices. Major elements of the policy reforms introduced the removal of price subsidies, compulsory licensing, and promotion of water trade to improve efficiency in water use and allocation. Figure 3 shows the institutional and policy structure of water policy reform in South Africa.

Figure 3: Current institutional organization of the South Africa water sector

The National Water Act (1998) and National Water Services (1997) in South Africa have been established with the ultimate objective of improving water allocation and reducing inequality in water access. Before the democratization of the country in 1994, water was allocated based on riparian principles and tied to land endowments. This means farmers having more land acreages were allocated more resources, leading therefore to a situation in which commercial large-scale farmers used to consumme more than 80% of the available resources (DWAs, 2011). Such a situation has created large discrepancy between competititing commercial large-scale and small-scale farmers. Since the majority of these large-scale farmers are white South Africans, this situation has contributed to enhancing racial division in terms of access to water resources. Therefore a better understanding of the extent to which transaction costs influence water policy implementation in South Africa allows us not only to analyse the policy that is the most suitable for implementation, but this contributes to observing the extent to which different farms groups and sizes react with regard to water reforms. The transaction costs are generally higher for small-scale farmers compared to the large-scale ones, since the latter benefit from economies of scale and have developed over the past years networks that protect them against risks and uncertainty that arise from interactions between water managers and farmers. Table 1 outlines the water policies considered in this paper and their associated transaction costs.

Table 1: Water policies, features and the related transaction costs

The extent to which transaction costs influence water policy reforms and social welfare is represented in Figure 4. Transaction costs have cross-cutting impacts on both water managers and users and they have been differentiated between permanent and temporary transaction costs. Permanent transaction costs influence water policy throughout its whole life cycle, from conception to final implementation, whereas temporary transaction costs only appear randomly and influence transaction costs at some particular periods in time. Beyond frequency in occurance, the extent to which transaction costs affect water policy outcomes depends also on the institutional arrangements put in place in the country to protect property rights and therefore mitigate the interests of the different actors along the policy life cycle (Saleh and Dinar, 2008). For instance introduction of NWA and NWS has enhanced the costs of coordination, since different stakeholders with diverse interests are gathered within the same institutional structures. Recent experiences in the Olifants river basin have shown that a combination of commercial large-scale and small-scale farmers have enhanced transaction costs of compliance to water tarriffing and compulsory licensing (Backeberg, 2006; Thiam, 2015; Hassan and Thiam, 2015). Since these two groups have diverse interests, the costs required to coordinate their actions enhance the total transaction costs. The additional advantage of adopted institutions is that they reduce uncertainty and risks that may affect farming activity.

Figure 4 shows the interplay of transaction costs along the entire process of the policy life cycle; from policy design to implementation and compliance. Water policy reforms in South Africa follow different steps ranging from policy design to enforcement, contracting, monitoring, implementation and compliance. The degree to which farmers adopt and comply to the policy depends not only to the characteristics (flexibility, transferability) of the policy itself but also to the socio-economic and technological features of the farming systems. For instance farmers with lower education or incomes are less likely to identify the transaction costs surrounding their farming activities (Igwe and Egbuson, 2013). At the same time poor farmers usually face more constraints in accessing the market, because of high transaction costs and low infrastructures, as outlined in the National agricultural program of the country (DWAs, 2011). Therefore beyond their effects on policy outcomes, transaction costs affect also farms' characteristics. This, in turn, affect compliance of farmers and their associated social welfare. Moreover, it is important to highlight that alternative regulatory actions taken in different sectors (agriculture, heath, etc) may influence the water sector, which as feedbacks influence water-related transaction costs, as outlined in the National Strategy of Water Reconciliation of the country. For instance previous studies have shown that previous regulations introduced in the South African agriculture through prices (subsidies and taxes) and non-price (quotas) measures have affected the transaction costs faced by small-scale farmers (Hassan and Thiam, 2015).

Figure 4: conceptualization of transaction costs

4. Empirical analysis

Our empirical analysis follows the previous works of McCann et al., (2005) and Ofei-Mensah and Bennet, (2013). We posit that total transaction costs represent the combination of support and administration, contracting, monitoring and enforcement costs. Support and administration costs cover the expenditures levied to create awareness of the policy and to increase its likelihood of acceptance by the different stakeholders. This is done through Government and local notices and hearings and in using private or public networks to clearly state the economic and social implications of water policy adoption. All the policies incorporated in the National Water Act have been published in the National Gazette in South Africa. Contract costs involve bargaining and decision costs and the costs spent in identifying opportunity. Monitoring and enforcement costs cover the costs spent to i) monitor compliance of farmers to the contract, ii) to mitigate third party effects and iii) infrastructure costs and costs of conflict resolution, respectively. Equation 1 shows the total transaction cost. As outlined earlier, three different phases are considered in our analysis: early implementation, full implementation and establishment program. Early implementation corresponds to the first step of policy implementation. This involves recruitment of administrative personnel to design and enhance adoption of new policy. This phase corresponds also to the elaboration of the policy in the public notices and hearings to get feedbacks from the stakeholders. When hearings are successfully concluded, the second phase of the policy (full implementation) comes into being. Parliament has passed the act and policies come into full effect. The last phase is the established program, a situation where policies are implemented and stakeholders routinely comply with the policy.

$$T_{ijt} = \sum_{t=1}^{3} \left(A_{ijt} + B_{ijt} + C_{ijt} + D_{ijt} \right) \quad (1)$$

Where transaction cost (T) is stratified for particular policies (i) of entities j. Five water policies (i= 5) and two paying entities (j = 2) are considered in this paper. Policies integrate water tariffs (water pricing), water trade, compulsory licensing, water user associations and effluent discharge. Two forms of paying entities are considered in our analysis: public and private entities. Public entities represent the water managers whereas private entities are the farmers using water for irrigation purposes.

4. 1: Empirical Specification

The second step of our empirical analysis allows us to estimate the determinants of the transaction costs the policies selected within the National Water Act (1998). This paper, therefore, identifies the factors influencing transacion costs in irrigation farmings in the Olifants river basin. Since little studies on the determinants of transaction costs have been conducted, this study should rather be taken as an exploratory analysis. Notwithstanding, we build on the past studies of Coggan et al., (2010, 2013) and extend the current state of the art in research and integrate the characteristics of the agricultural sectors of the Olifants region. The determinants are estimated using an Ordinary Least Squares (OLS) regression, as outlined in Verbeek, (2012). Equation 2 shows our econometric specification.

$$T_j = \mu_j + \varepsilon_j \tag{2}$$

where T_j measures the total transaction costs for entities j of irrigation farming households and managers for the selected five policies across the three duration phases, as stated in Euqation 1. The vector μ_j includes the observable factors that are likely to influence the magnitude of transaction costs and the last term ε_j represents the error term. From Equation 2, we derive the implicit functional form of the model, represented in Equation 3.

$$TotalTCs = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e \tag{3}$$

Where the total transaction costs (TCs) (in Rand) represents the continous dependent variable. Three determinant vectors are considered in this analysis: vector of transaction characteristics (X1), vector of institutional environment and arrangement factors (X3) and vector of transactor (entity) characteristics (X2). This specification is made following Coggan et al., (2010) who show that transaction costs are influenced by factors such as transaction and transactor characteristics and institutional environment and arrangement. These factors influence transaction magnitudes by affecting activities such as information gathering, implementation, administaration, contracting, monitoring and enforcement costs (Coggan et al., 2010). Transaction characteristics explore factors related to asset specificity, timing or frequency of the transaction and uncertainty surrounding farming activities. Transactor traits, on the other hand, explore factors in relation to opportunism, bounded rationality, common ideas and social cohesion in addition to demographics. Lastly we also discuss the institutional factors important in driving policy. Finally ε represents the error term of our specification. Based on the previous studies, transactor traits (characteristics) represent the features of the selected entities (farmers) such as information on geographical locations of respondents, number of household member, gender, marital status, farming experince, race and schooling years. The transaction features represent information that may influence acceptance and compliance of water policy reform. They represent, for instance, the type of policy use, technical assitance received by farmers and the volume of water consummed for irrigation and production purposes. Factors included through institutional environment and arrangements include distance to market, leadership positions in WUAs, tenure security and farm size and income.

4.2 Data

Data was collected through a survey from a total of 183 irrigation farmers and 16 water managers in the Olifants basin. We used a semi-structured questionnaire to elicit information on household characteristics, farm activities, water policy compliance, and individual estimates of transaction costs for policies relevant to each respondent across the three time durations. The first step was to find out how many of the five policies investigated a farmer had complied to. Under each policy, we outlined the transaction cost types i.e. support and administration costs, contracting costs, monitoring costs and enforcement costs. Under these transaction cost types, we outlined the relevant activities through which a respondent would incur transaction costs; these were costs incurred in meetings, travel, communication, negotiation, giving notices and hearings, and financing. Focus group discussions were further conducted with leaders of water use groups, extension personnel and farmers to substantiate the farmer interview responses. Departmental budgets and reports from the Department of Water Affairs for the past 10 years were also obtained to identify and complement incurred transaction costs for water policies. Budgets and records complemented information obtained from water managers. They gave information on staff numbers, their salaries by level, amounts of money budgeted and incurred for policy activities and time allocated to policy activities. Additional information was obtained through emails, phone calls and informal personal communication. Limitations faced in our data collection processes include; lack of records for transcation costs especially for the farmers. Therefore costs obtained were based on recall for past phases which was difficult. Another problem was failure to attend to interviews by irrigation water users and reluctance by ministry staff to avail information.

Table 2: Summary statistics of variables included in the regression analysis

5. Results

In assessing the transaction costs associated with five water policies in the Olifants river basin in South Africa, we differentiated between water users and managers' transaction costs. Results are therefore, presented following this distinction.

5.1 Water users' transaction costs across policies

Table 3 shows transaction costs associated with each of the selected five policies. Results show that most water users report transaction costs related to contracting costs for the policies they comply to. This concurs with the findings of McCann & Easter, (2004); and McCann et al., (2005) who identified contracting costs as the main components of transaction costs. On the other hand, water tariff is the most popular policy among water users in the Olifants river basin. They encompass 35% of the compliers followed by WUAs and compulsory licensing accounting for 34% and 16.8% in compliance, respectively. Water trade is currently non operational and farmers who have been interviewed were not able to document any transaction costs associated with water trade as the existing water exchanges that occur in certain catchments (Orange river basin) are carried out informally, without any legal and financial underpinnings. The effluent discharge payments for transaction costs are mainly incurred by industries at their own individual capacities since the effluent permit system by the Department of Water Affairs has not officially kicked off. In total across all policies, monitoring costs are the highest followed by contracting then administration costs. Contracting transaction costs by water users are reported for majority of the policies while monitoring costs are reported for effluent permits and WUAs only. Administrative transaction costs are the lowest since they are only reported for the WUAs which involves participation by users. Monitoring costs are the highest but mainly from effluent industry discharge management. Enforcement costs are not reported for any of the policies. The effluent permit costs are way too high in comparison to the other policies; this is attributable to the different scales of operation between farming and industrial water uses. As earlier mentioned, the effluent discharge permit system is not officially operational in South Africa. DWA is currently conducting its implementation trials for this policy in some parts of the

Olifants. For the purposes of this study, the effluent discharge policy transaction costs measured, are from independent pollution analysis by industries.

Table 3: Total transaction costs across policy options

Figure 5 indicates the percentatges of contracting costs between the four policies (water tariffs, compusory licensing, effluent permits and WUAs). Water tariffs are reported as having the highest of all transaction costs at 47% , probably because this is one of the widely adopted policy across the Olifants river basin. Transaction costs incurred for the effluent discharge payment policy are second highest at 25 percent. Compulsory licensing transaction costs are third in magnitude at 19 percent. This could be because this policy is not so widespread in terms of user compliance and the fact that its payment is made once per annum. Compulsory licensing also remains a new idea for many water users. Formation of water use groups here in referred to as WUAs is last at 9 percent of reported transaction costs. We attribute this to the already established WUAs which have been in operation for many years starting as far back as 1930's especially for the commercial farmers. This implies that their systems are already in place and not much of operational transaction costs are incurred. Similar suggestions are reported in Falconer et al., (2001). As for the small scale water users, they are organized into small informal groups and report minor transaction costs as well. As water tariffs have the highest reported transaction costs, we highlight the specific transaction cost elements (travel, telephone, additional information costs, finance and decision costs) and their magnitudes in figure 6. We find that all of these elements are high during the early implementation phase of the water tariffs and decline over time. However, costs incurred to arrange for finance remain constant over the three time durations probably because water payment remains constant throughout.

Figure 5: Contracting costs across four policies

Figure 6: Water Tariff contracting cost components over time

We further compared user transaction costs across policy over the three durations considered in this study (early implementation, full implementation and established program). The results are indicated in figure 7. They show that for all the cost components across the policies, transaction costs are higher during early implementation and slightly decrease through to establishment program. This is also true for water manager transaction costs. We attribute this to smoothing out of costs as a policy gets implemented and experience is gained. Similar suggestions are reported by Coggan et al., (2010 ; Falconer et al., (2001) and Rørstad et al., (2007).

Figure 7: Transaction Costs incurred by water users across the three durations

5.2. Water managers' transaction costs across policies

We assessed transaction costs faced by water managers to signify the cost of policy implementation. Our findings show that across the policies implemented, transaction costs incurred by water managers varied between 17 - 24 percent as indicated in Figure 8. This pointed out to an almost similar budget allocation for all the policies within the water ministry. Compulsory licensing had the highest incurred transaction costs at 24 percent probably signifying its level of prioritization amongst the water policies. Water trade and effluent discharge transaction costs were also high at 21 percent, despite the policies being non operational. This signified efforts made towards operationalizing water trade and the effluent permit system. transaction costs incurred for water tariffs and WUAs were the least at 17 percent for each, probably indicating less activities and efforts from the water managers to implement the two policies. WUAs only required involvement of water managers at the inception stages while water tariffs were somewhat operational but lacking consistent follow ups.

Figure 8: Water managers' Transaction Costs across policies

The pie charts in figure 9 depict an assesment into specific policies. They reveal that support and administration costs were the highest for all the target policies of implementation. The administration costs were 78, 58, 78, 80 and 64 percent for compulsory licensing, water tariffs, effluent permits, water trade and WUAs respectively. This was expected as similar indications are made in previous studies by

McCann & Easter, (2004), McCann et al., (2005) and Falconer, (2000). Moreover managers tend to have more control over administrative costs than other transaction costs. Administration costs further tended to be fixed over time. Monitoring costs in water management closely followed in magnitude for all the policies. Contracting transaction costs by water managers were only reported for the WUAs. This was because of an initial level of involvement between the irrigation farmers and the government in formation of WUAs unlike for other policies (Jean de la Harpe, n.d.;Gazette, 1998).

Figure 9: Water management transaction costs by cost components

Figure 10 indicates water management transaction costs magnitudes over the three time periods studied. The figure shows that effluent discharge and water trade transaction costs are very high in the inception period and minimal in later durations of implementation. The early high implementation transaction costs could be good indicators of why these two policies are not yet steadily operational several years after the 1998 water Act. The initial high transaction costs for water trade could point to the aborted implementation of the policy in the Olifants region while the insignificant later transaction costs indicate the current policy stagnation. Similarly, the initial high transaction costs for the effluent discharge system could explain the delayed kick off for this policy. Compulsory licensing and water tariffs management transaction costs show an almost uniform trend with minimal variation over the three time periods. The transaction costs do not smoothen out over time and we link this to current non optimality in implementation

Figure 10: Water managers' transaction costs across the three time periods

5.3. Determinants of transaction costs

This section discusses results of the OLS regression given in table 4. The results showed that various factors significantly influenced transaction cost magnitudes incurred by irrigation farmers. The model fitted the data well with an F statistic of 0.0000. We tested for multicollinearity using the *vif test* and from the correlation matrix, explanatory variables with correlation coefficients of greater than 0.5 were dropped. All variables included in the final model did not show evidence of multicolinearity. In addition, the regression model was approximated using heteroskedastic-consistent-standard error estimators.

Table 4: Determinants of transaction costs in the Olifants basin: OLS results

Results from the OLS regression indicate that some of the assessed factors significantly determined transaction costs incurred by irrigation water users. Firstly, the results show that irrigation water users involved in WUAs were likely to incur higher transaction costs than non members. Farmers who complied to water pricing were also likely to incur higher transaction costs than those who did not. This suggest that compliance to water policy is indeed underlied by transcation costs. The results further indicate that farmers from the lower Olifants region were likely to incur significantly lower transaction costs compared to farmers from the upper Olifants region. We posit that farmers in the lower Olifants region did not actively participate in the water policy process due to the subsistence nature of their farming.They therefore incurred lower transaction costs compared to their upper Olifants counterparts who were mainly largescale farmers. The results further supported this and indicated that small scale farmers and people with other occupations outside farming faced lower transaction costs compared to the large scale farmers. This result implied that this category of farmers was less likely to participate in irrigation water use activities therefore less transaction costs of policy compliance.

Higher levels of income on the other hand, were associated with lower transaction costs magnitudes. Irrigation farmers with higher incomes were likely to incur lower transaction costs. From the study sample, large incomes were linked to largescale irrigation farming. We argue that economies of scale in largescale operations are likely to obtain cost advantages as their outputs increased leading to lower variable costs. Results further showed that irrigation water users who obtained their policy information via information and communication tehnology (ICT) related means such as radio, televisions, phones and emails incurred less transaction costs compared to non users. This was in line with recent developments which portray the potential of ICT in decreasing transaction costs (Singh, 2008; Okello, 2011; Aker, 2010; Silva et al., n.d.;Jensen, 2007; Aker, 2008). ICT eases the communication of knowledge and information resulting in decreased bounded rationality and transaction costs.

The water quality categories used in the regression were as perceived by farmers following the definitions by DWA as '*ideal (good)'*, '*acceptable (moderate)'*, *'tolerable (bad)'* and *'unacceptable (very bad)'*. The results indicated that irrigation farmers who used water quantities of acceptable quality were likely to incur lower transaction costs of water policy compared to farmers who used water of ideal quality. We postulate that farmer recipients of acceptable water quality lacked the incentive to comply to water policies and therefore incurred lower transaction costs unlike their ideal water quality counterparts. A secure water supply with guaranteed quality would on the other hand encourage irrigation investment and compliance to proposed water policies. Lastly, the study findings showed that white farmers were likely to face higher transaction costs compared to their black counterparts. We linked this to their higher level of involvement and compliance to water policy compared to the black small scale farmers. Coggan et al., (2010) suggest that transaction costs should be dissimilar between parties, and are uniquely affected by the interelationships between parties.

6. Conclusion

Following McCann & Easter, (2004); and McCann et al., (2005), this study identified and quantified the ex post transaction costs related to the water policy process in the Olifants basin of South Africa. The study focussed on irrigation water users' and public agents transaction costs. The results indicated that sizeable amounts of transaction costs were incurred by the two groups of stakeholders. The public agents transaction costs remained higher than the water users' ones. This could be explained by the high support and administration costs which minimally varied over the three time periods (early implementation, full implementation and established program). Transaction costs were high for the widely implemented policies but they fairly decreased in the course of policy implementation. The transaction costs incurred by irrigation water users mainly comprised of travel, telephone, additional information costs, finance and decision costs .Very high start up transaction costs were associated with the implementation of water trade; a policy that is currently non operational in the Olifants. High start up transaction costs were also associated with the effluent discharge system; a policy which is yet to kick off. We conclude that different levels of transaction costs for the different water policies existed in the event of policy implementation and compliance. This is an important feedback for the water policy process in South Africa. Knowledge of the relevant and existing transaction costs prior to policy choice and implementation increases the likelihood of the policy to be easily implemented. Moreover, it helps to make comparisons between policy alternatives and nurture effective design and implementation ex ante. It further permits evaluation of existing policies ex post for improvement purposes, and assessment of their budgetary impact to establish their sustainability and efficiency.

The study results further showed that different factors explained transaction costs differently. These factors can act as policy indicators towards better transaction costs management. For example, the significant negative effect of ICT tools used to acquire information for water management shows how ICT can save on information gathering costs. We recommend investments in information collection, analysis and better dissemination by the public agencies. Research that is more empirical would also deepen the understanding of determinants of transaction costs and help to establish a more general theory on the matter. It would further aid future predictions of the interactions between factors; especially on the direction, they influence transaction costs.

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Tables

Table 1: Water policies, features and the related transaction costs

Water policies	**Features**	**Associated transaction costs**
Water Tariffs	• Promote efficient re-allocation of water resources • Water scarcity is taken into account in the pricing mechanism • Develop more efficent water use practices (efficient irrigation technology, demand management practices, control of water value chain, etc.)	• Contract costs • Administrataion and support costs • Coordination costs • Information costs • Compliance costs
Water Trade	• Promotes exchange of water-use rights between actors • Develops a water market to facilitate transactions • Contributes at demand and	• Coordination costs • Information costs • Administration and support costs • Contracting and detection costs • Monitoring and

	resources management	negotiation costs • Lobbying costs • Enforcement costs
WUAs	• Involve local stakeholders in the management of the resources • Integrate local spatial and gender features on the design of water policy • Promote a decentralized and inclusive water management practices	• Contracting and detection costs • Enforcement costs • Coordination costs • Enforcement costs
Compulsory licensing	• Correct pas-discriminatory water allocation practices • Promote a rise of emerging farmers in re-allocating water use rights • Disconnecting water right to land-ownerhsips (riparian principles)	• Contracting and detection costs • Administration and support costs • Information costs
Effluent discharge	• Reduce water pollution and improve water quality • Develop end-of-pipe water treatment technology to mitigate pollution • Improve soil quality for irrigated agriculture • Mitigate effects of climate change	• Contracting costs • Monitoring and negotiation costs • Adminstrative costs • Compliance cost

Source: Author compilation

Table 2: Summary statistics of variables included in the regression analysis

Variable	Mean	Std. Dev.	Min	Max
Total TCs	2738.13	4428.29	0	19960
Region	2.48	0.80	1	3
Distance market	50.10	54.98	0	300
Leadership	0.06	0.24	0	1
Race	0.20	0.40	0	1

Gender	0.56	0.49	0	1
Schooling-years	8.66	5.52	0	24
Occupation	1.84	0.73	1	3
Farming-years	19.42	13.26	1	55
Farm size	71.32	170.80	0.05	900
Tenure security	0.072	0.25	0	1
Water quality type	2.03	0.88	1	4
Water cost	0.40	0.23	0	0.44
Information source	0.47	0.89	0	5
ICT tool	0.62	0.48	0	1
Lncome	11.46	2.81	0	20.07
Policy_WUA	0.43	0.49	0	1
Policy_Licensing	0.08	0.27	0	1
Policy_ water tariffs	0.24	0.43	0	1

Source: Author compilation

Table 3: Total transaction costs across policy options

Water policy	Number of water users compliant	Administartion Costs	Contracting Costs	Monitoring Costs	Enforcement Costs	Total for each policy
Water tariffs	81	_	638495	_	_	638495
Water Trade	16	_	_	_	_	_
WUAs	80	112770	112432	220613	_	445815
Licensing	39	_	261099	_	_	261099
Effluent discharge	15	_	341400	15187100	_	**15528500**
Total by policy component	231	**112770**	**1353426**	**15407713**	_	16873909

Source: Author compilation

Table 4: Determinants of transaction costs in the Olifants basin: OLS results

Variable	**coefficient**	**Standard error**	**p-value**
WUA-membership(1=yes,0=no)	3014.151***	402.523	0.000
Compulsory Licensing (1=yes,0=no)	1.376.734	1.156.852	0.236
Region- Middle Olifants	3047.438	1.003.607	0.003
Region- Lower Olifants	-182.382***	1.010.184	0.857
Leadership in WUA(1=yes, 0=no)	-770.656	1.103.856	0.486
Gender(1=male, 0=female)	-22.894	276.283	0.934
Years of schooling	-38.501	29.734	0.197
Main occupation-small scale	-1076.641*	624.025	0.086
Main occupation-other	-1686.291**	649.051	0.010
Farming years	-12.102	12.017	0.315
Farm size- natural log of farm size	0.504	1.942	0.796

Landclaims (1=yes,0=no)	36.173	712.445	0.960
Income- ln income	-123.763*	67.200	0.067
Technical assistance (1=DWAF,0=others)	165.253	446.972	0.712
ICT tool	-879.440**	349.247	0.013
Water cost- ln water cost	181.179***	65.185	0.006
Water quality-acceptable	-689.893*	372.271	0.066
Water quality-tolerable	-659.207	415.940	0.115
Water quality-unacceptable	-439.190	597.989	0.464
Market distance	-4.368	4.186	0.298
Race	3666.637***	1.280.231	0.005
_cons	1.862.453	1.447.012	0.200
N=179	R^2 =0.815		P=0.000

Source: Author compilation

Figures

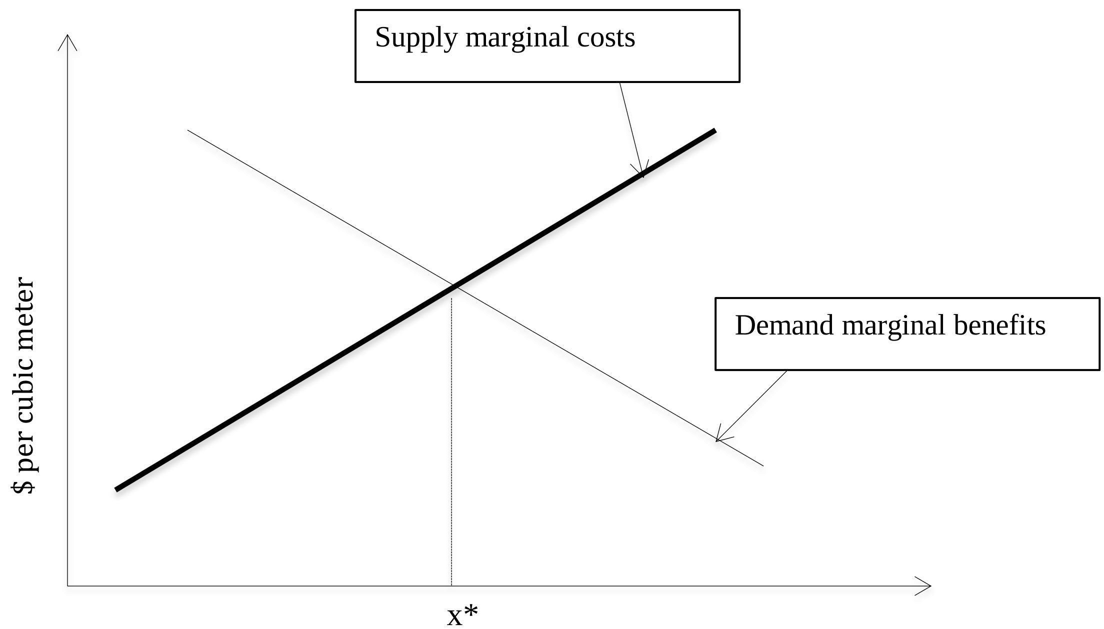

Figure 1: distortion between water supply and demand

Source: Author compilation

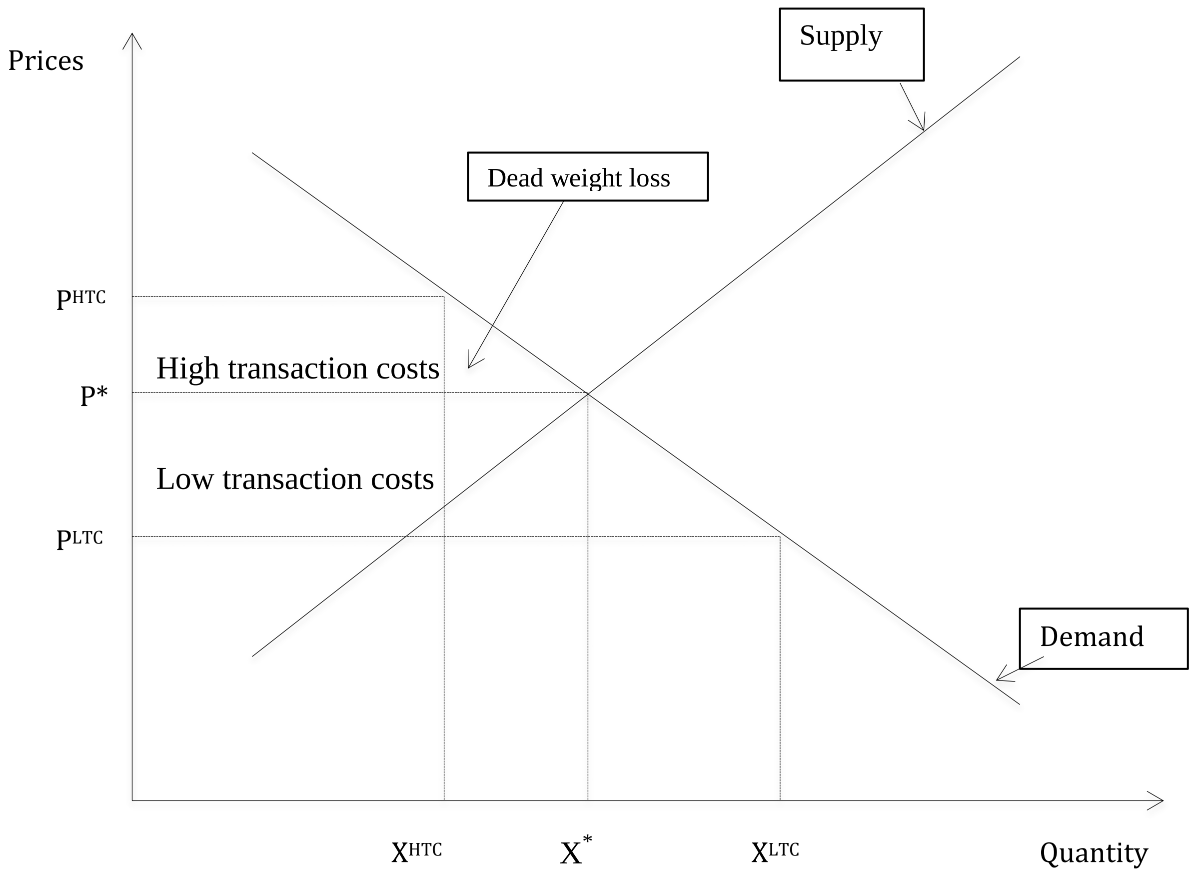

Figure 2: water allocation measures with transaction costs

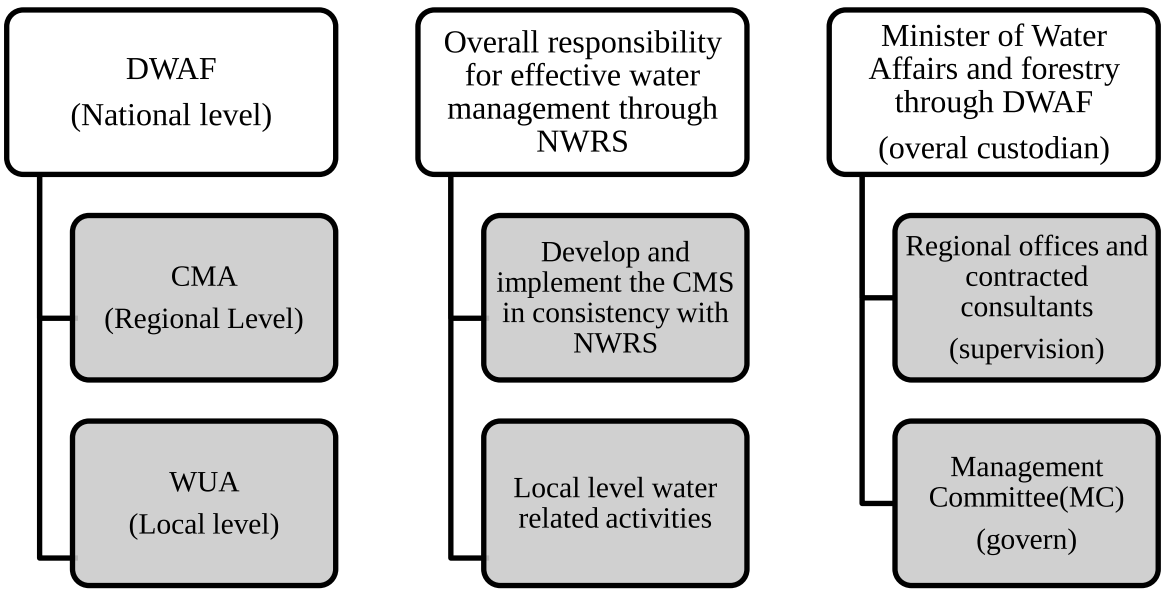

Figure 3: Current institutional organization of the South Africa water sector
Source: (Harpe & Ramsden, 1999)

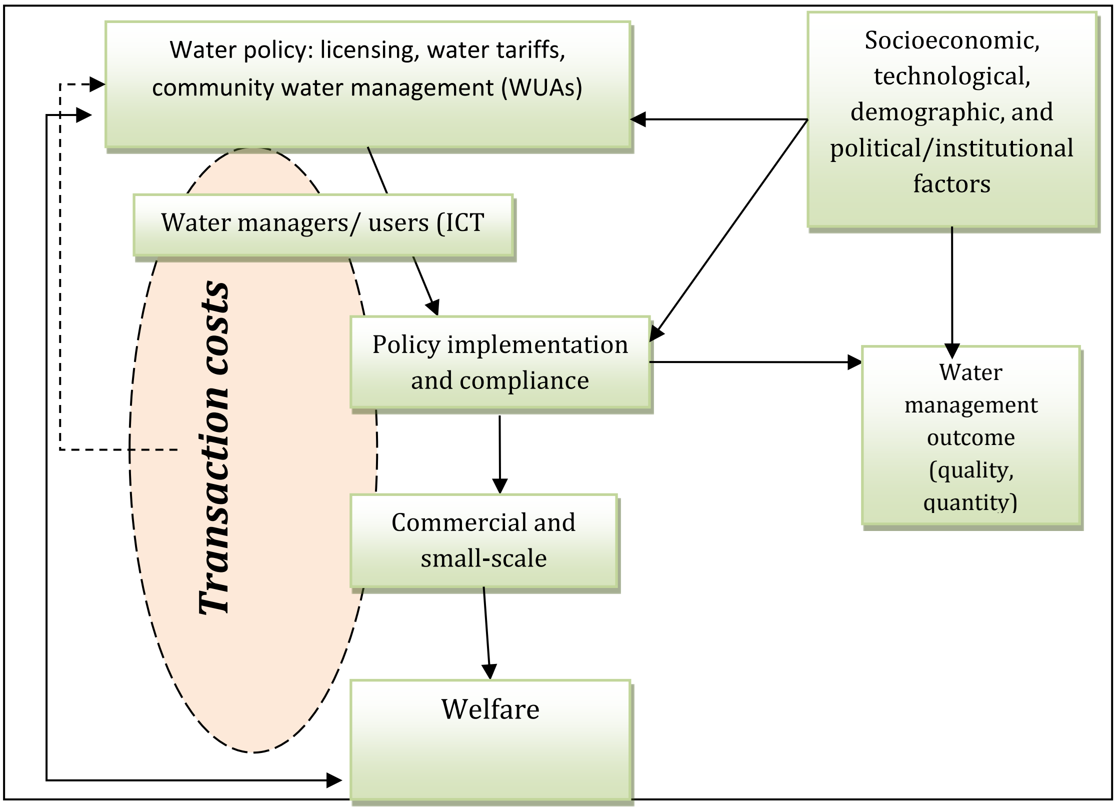

Figure 4: conceptualization of transaction costs
Source: Author compilation

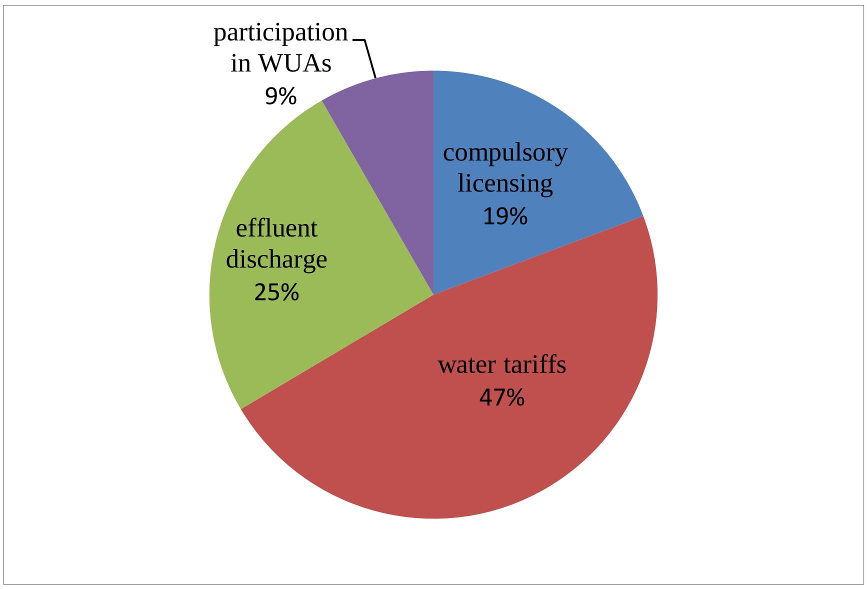

Figure 5: Contracting costs across four policies
Source: Author compilation

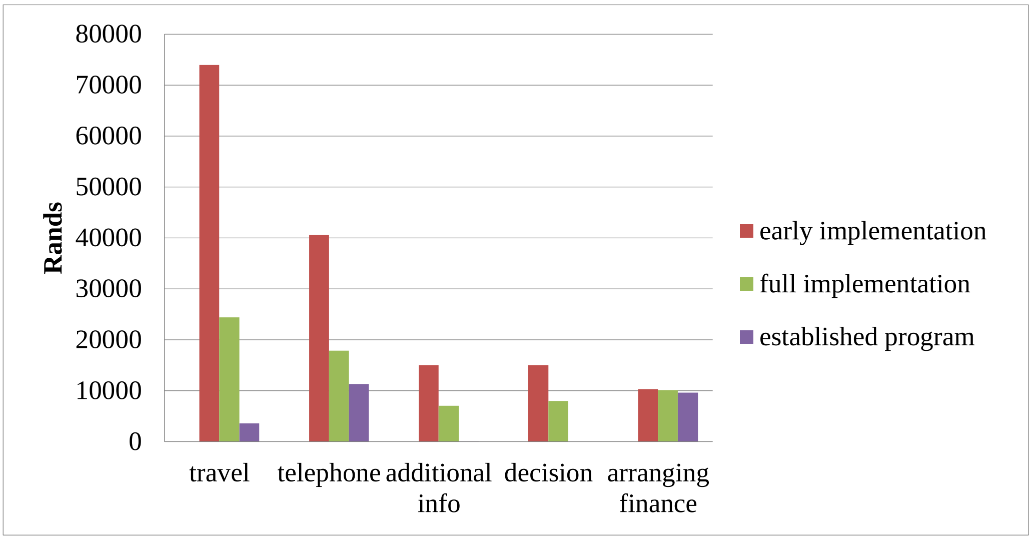

Figure 6: Water Tariff contracting cost components over time
Source: Author compilation

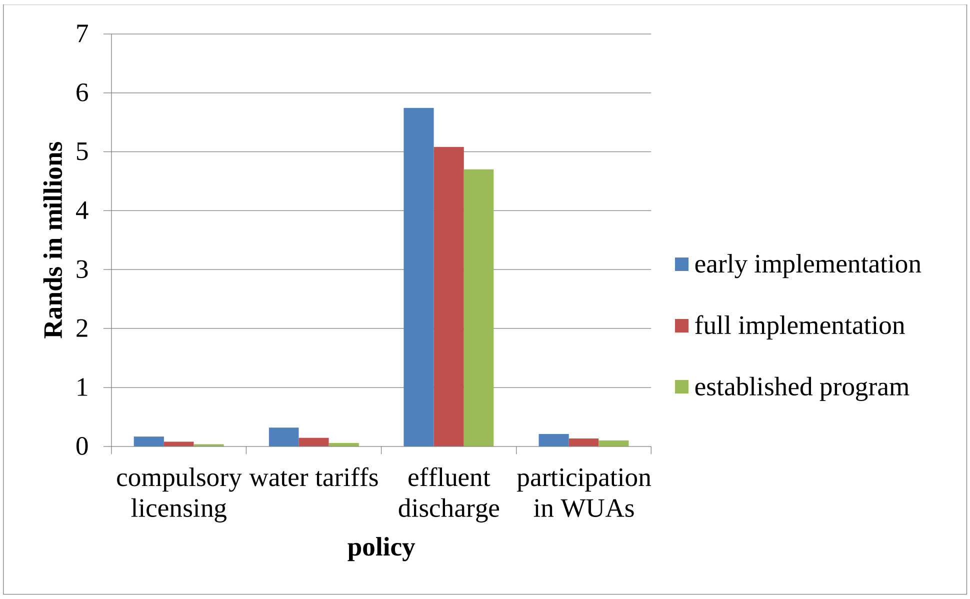

Figure 7: Transaction Costs incurred by water users across the three durations
Source: Author compilation

Source: Author compilation

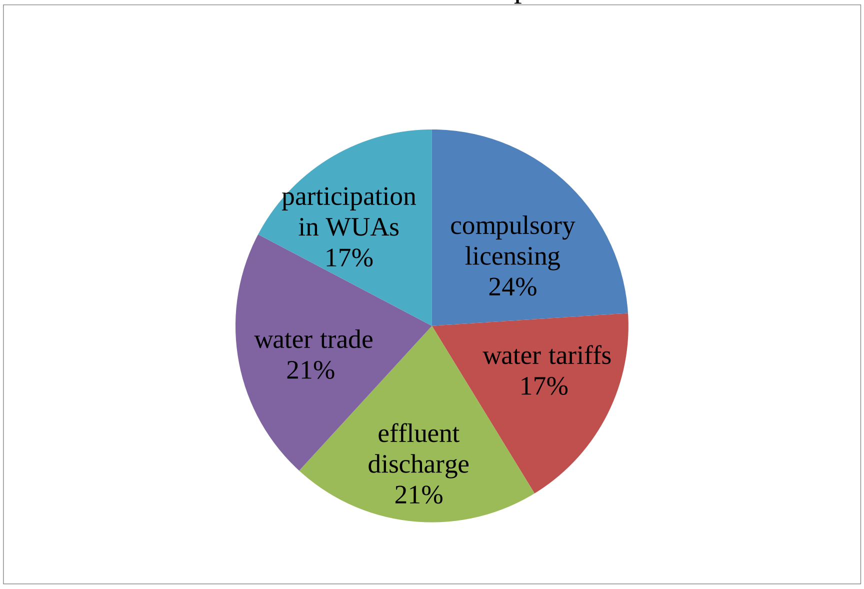

Figure 8: Water managers' Transaction Costs across policies
Source: Author compilation

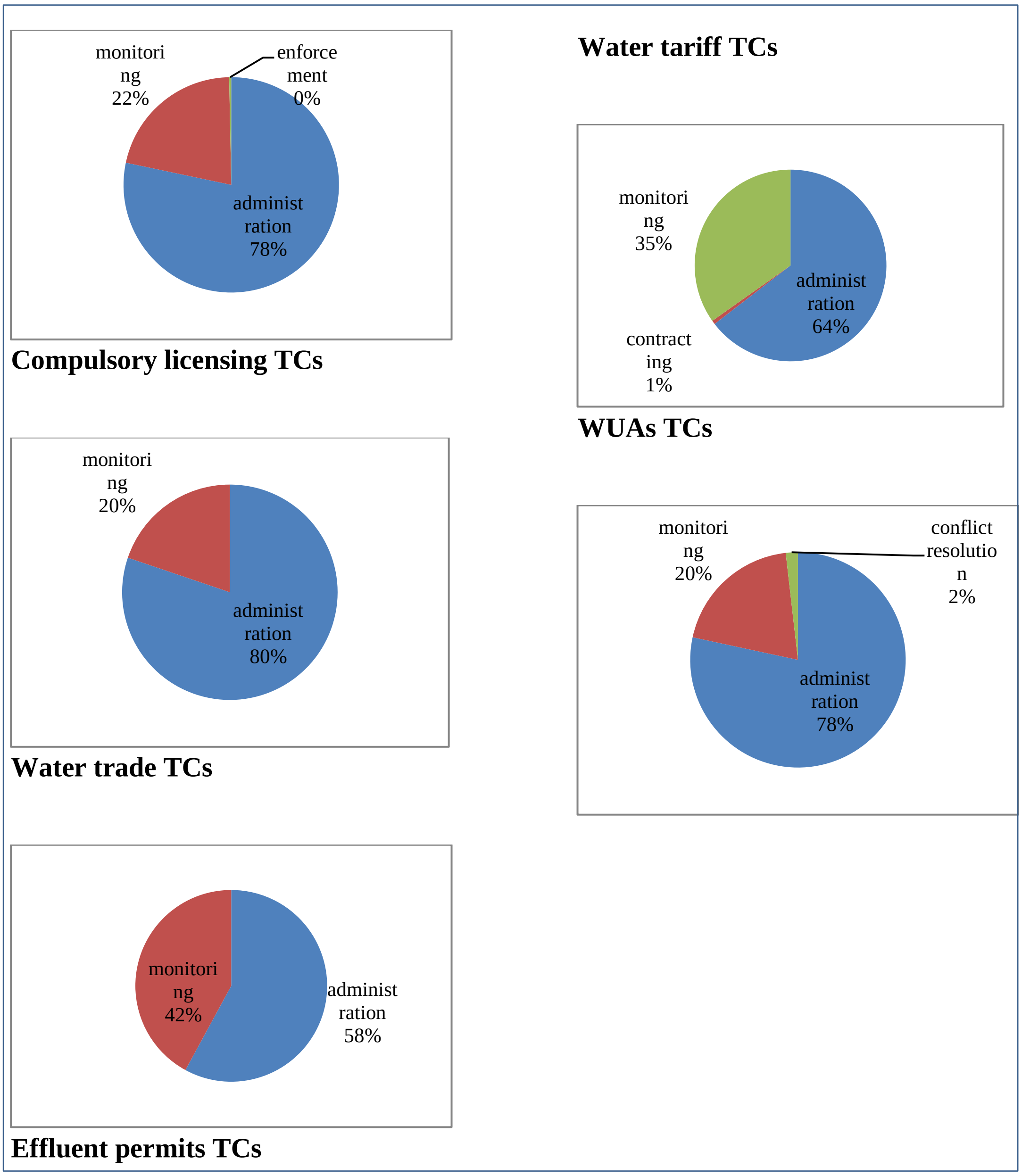

Figure 9: Water management transaction costs by cost components
Source: Author compilation

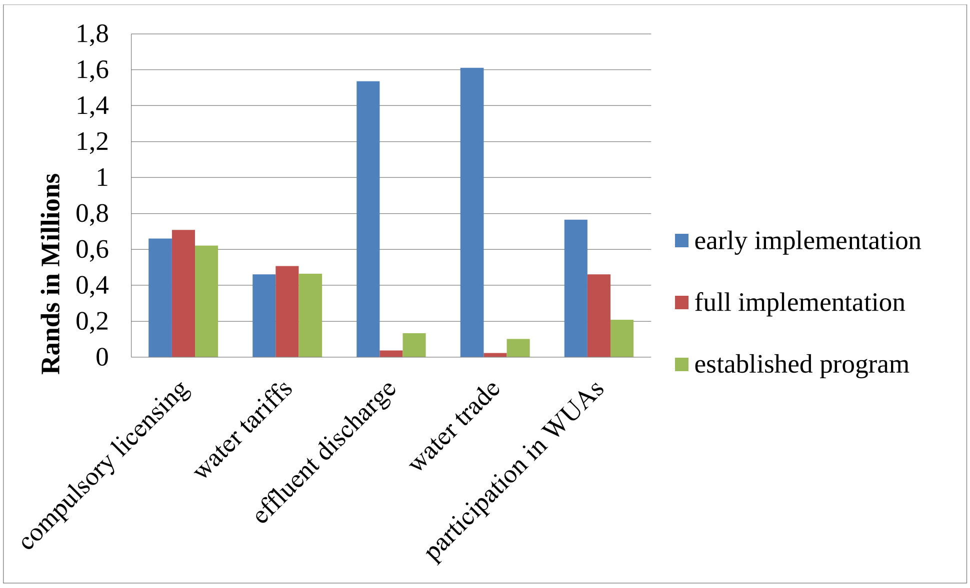

Figure 10: Water managers' transaction costs across the three time periods
Source: Author compilation