The Process and Performance of Decentralization of River Basin Resource Management: A Global Analysis

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THE PROCESS AND PERFORMANCE OF DECENTRALIZATION OF RIVER BASIN RESOURCE MANAGEMENT: A GLOBAL ANALYSIS

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Abstract. This paper focuses on empirically assessing determinants of river basin management decentralization, which is poorly understood while growing in popularity world wide. Measuring decentralization as a shift of decision making responsibility to water users or governments at the river basin level or below, the analysis sheds light on the decentralization reform process and its success, using primary data from 83 river basins world wide. Contrary to common perception water scarcity is found to be a stimulus to reform and financially endowed or developed basins do not outperform poor an underdeveloped basins; conditions improving decentralization performance include: existence of dispute resolution mechanisms; greater financial responsibility of users; and external government financial support of basin budget.

Key words: Decentralization, political economy, economic efficiency, water, river basin.

JEL Codes: Q25, Q34

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THE PROCESS AND PERFORMANCE OF DECENTRALIZATION OF RIVER BASIN RESOURCE MANAGEMENT: A GLOBAL ANALYSIS

1. Introduction

Decentralization[1] has become one of the most debated reform issues in many sectors around the world in recent years. On the one hand it is argued (e.g., Besley and Coate, 1999; Conyers, 1984; Shah, 1998; Wallis and Oates, 1988) that by having the service receivers part of the decision making process, the service provider—in most cases central governments—responds better and in an equitable manner to local needs, and thus, efficiency gains from lower transaction cost are realized. On the other hand, others (Smith, 1985; Wandschneider, 1984) argue that lack of local capacity, diseconomies of scale, and politics of local interest groups will make provision of decentralized services inefficient. Recently, Sigman (2005) asserts that decentralization of water quality regulations may be associated with externality costs when pollution crosses the borders of the decentralized jurisdictions. In a somewhat similar vein, Howe (2005:26) argues that "…breaking up river basins among many jurisdictions, most having nothing to do with water", leads to "jurisdictional externalities". The examples used by Sigman (2005) and Howe (2005) refer to transboundary river basins (see footnote 7), either in a federal country (e.g., USA) or in an international setting. We would argue and try to show in this paper (for river basin) that whether or not decentralized services are more efficient or less costly than those associated with centralized provision is an empirical question, depending on, for example, initial conditions, scale, type of decentralized services, and other factors.

Water, an increasingly scarce resource around the world, has been usually (mis)managed by governments, leading to several social and economic problems, including degradation in its quality and reduction in the level of services it provides. In the case of river basin water resource management, there have been problems stemming from the common pool nature of the resource and the existence of severe externalities from its use by individuals and sectors in various parts

[1] Decentralization is usually defined as a redistribution of authority and allocation of resources with more power being shifted away from the central or national level to lower levels of government.

of the basin. With central management often lacking appropriate incentive structures and imposing high transaction costs of management, these problems have been exacerbated, leading to recognition of a need for a paradigm shift in river basin water resource management.

One of the major components of the recent water reforms at the basin level is the decentralization of basin water resources management to *the lowest appropriate level*, as widely advocated in the Dublin Principles (ICWE, 1992:4), by the World Bank's Water Resources Policy Paper (World Bank, 1993:18), and by the Global Water Partnership working paper (GWP, 2000). The lowest appropriate level usually implies the involvement of stakeholders in the basin, including water users. On the one hand, decentralization is the devolution of authority and accountability from the central to lower levels of government. Clearly, this form of decentralization is likely to vary across countries according to their size and governance structure. Moreover, when power is devolved, overlapping functions across authorities and competition between them have to be considered. Yet another dimension of decentralization is the extent to which users and other stakeholders participate in the decision making process. Devolution of power to lower levels of government and stakeholder participation may go together but that need not always be the case. Following Wallis and Oates (1988) we take Decentralization of river basin water resource management[2] to mean the shift of decision making responsibility to water users or governmental units at the basin scale or below. Such decentralization reforms are usually promoted for the purposes of increasing transparency and stakeholder participation in decision making, which are expected to result in improved water resource management outcomes. We would state here that river basin is clearly not the lowest level to which responsibilities for water resource management can be decentralized (Howe 2005). However, since we confined our study to the river basin scale, then the river basin is the lowest level to which its management can be decentralized.

Decentralization of water resource management from centralized national administration to the basin level is an important aspect of reform agendas, with governments and international development organizations, such as the World Bank, funding projects with decentralization

[2] From hereafter we use 'decentralization of river basin water resource management' interchangeably with 'river basin management decentralization' and 'river basin decentralization'.

components (Figure 1). However, evaluation of such major investments has not been performed and lack of understanding of both the decentralization process and its performance hamper the possible improvements of similar investments in the future.

The documented decentralization reforms of river basin water resource management do not address process and performance aspects. The common approach is a case study of a single or a few basins (Kemper and Olson, 2000; Zusman, 2000; Reynoso, 2000; Merrey, 2000; Ioris, 2001; Koppel, 1987; Udofia, 1988; and Blomquist et al., 2005). While the case study analyses highlight the direction in decentralization of river basin management, they do not permit the identification of generic reasons and forces behind decentralization process and performance.

Since rigorous analysis of decentralization of river basin management that is not specific or descriptive is rare, we consulted works that evaluate decentralization in other sectors (Mody 2004; Faguet, 2004; Cerniglia, 2003; Panizza, 1999; Humplick and Estache, 1995). The work by Faguet (2004) and Cerniglia (2003) in particular address, at a different scale and context, research questions that coincide with ours. Faguet (2004) examines whether decentralization increased the responsiveness of public investment to local needs in 10 sectors in Bolivia. Cerniglia (2003) investigates the determinants and the performance of fiscal decentralization in 16 OECD countries with specific focus on federal vs. unitary countries. A common phenomenon in these studies is that they rely on existing datasets and thus, need to adapt and restrict their set of empirical variables to that in the dataset they obtained.

In this paper we develop an empirical framework based, in part, on an analytical framework developed in Blomquist et al. (2005), Cerniglia (2003), and Faguet (2004). The framework permits a quantitative estimate of the relationships that explain processes and performances of river basin decentralization reforms. As we could not get an existing data set that fits our analytical framework, we developed a questionnaire that was administered to collect data, which we then analyzed to test our hypotheses. The rest of the paper is organized as follows: the next section presents the analytical framework and the hypotheses we will test. Section II presents the data collection and manipulation procedures. Section III presents and justifies the empirical models we constructed, and section IV reports the results of the analysis. The conclusion suggests lessons for both researchers dealing with assessing progress in

institutional reform and for policy makers dealing with decentralization of river basin management and other related sectors.

2. Analytical Framework and Hypotheses

We start with the observation that "the lowest appropriate levels" for river basin water resource management vary between basins, i.e. while full decentralization of decision-making can be optimal in one case, it can be destructive in others. Therefore, our framework incorporates factors such as basin size, hydrology, socio-economic conditions, governance and cultural and historical conditions in each basin (see also Saleth and Dinar, 2004:242-260).

In addition to the specific local context of the decentralization process, an important issue to address is what to measure and how to measure it. Decentralization of decision-making is not an aim *per se*. It is recommended because experience suggests that when decision-making is centralized and local conditions are not taken appropriately into account, then accountability of decision makers is weak, and water resources management is hampered.

Decentralization can be seen as a reform process and as such, other processes that occur in parallel may affect it. For example, forces initiating and affecting the decentralization process stem from societal structure, interests leading to the reform (top down or bottom up), and rules governing the initiation and approval of organizational change among others (as discussed at length in Blomquist et al., 2005). Furthermore, the concept of path dependency plays a major role in the process of institutional reform (Saleth and Dinar, 2004:264). The process by which decentralization measures are introduced is expected to affect implementation and performance. The costs and benefits encountered by different stakeholders as well as power relations between them are also important variables in our analytical framework (Saleth and Dinar, 2004, Chapter 4). Our analytical framework thus takes into account (a) the existing institutional framework, (b) the decentralization process, (c) the basin political economy and (d) the decentralization results.

As institutional analysts have studied natural resource management in general—and in some instances, water resource management in particular—they have identified causes and patterns of interactionamong groups and individuals. Much of this work is summarized in Bromley (1989), Ostrom (1990) and Ostrom et al. (1994). Key considerations identified in the literature include: (a) asymmetries of power, information, or other resource distribution among

individuals; (b) Past interactions among individuals and their anticipations concerning future interactions; (c) the extent to which individuals are allowed or encouraged to innovate, experiment, and pursue trial-and-error learning with respect to institutional arrangements; (d) social (or otherwise derived) norms of trust and reciprocity; and (e) cultural or other differences among the individuals who are attempting to coordinate behavior or whose cooperation is needed. Ee have transformed those broad categories into empirical variables, and formulated hypotheses about how each variable might contribute to the likelihood of successful or unsuccessful decentralization of river basin management.

2.1. The Hypotheses

We start by postingour research questions: (1) What is the role of historical and situational variables on the level of stakeholder involvement in the management of the basin, and if such active involvement of stakeholders is secured, how can it be translated into more effective resource management and higher performance level compared to the situation prior to decentralization? (2) If stakeholder involvement is translated into basin-level management, how can the active involvement and effective resource management be sustained over time and changing conditions? (3) What factors might account for the longevity of decentralized arrangements in some cases and their demise in others?

Guided by these research questions, our analytical framework helped identifying four sets of variables under the major headings (a) Impact of contextual factors and initial conditions; (b) Characteristics of the decentralization process; (c) Characteristics of central government/basin-level relationships and capacities; and (d) The internal configuration of basin-level institutional arrangements. For each set we develop a list of empirical variables that could capture expected relationship to decentralization process and performance.

2.1.1. Impact of Contextual Factors and Initial Conditions

The literature on decentralized water resource management indicates that the outcome of decentralization is partly a function of the initial conditions that prevail at the time a decentralization initiative is attempted (*path dependency*). These initial conditions are elements of the economic, political and social context of the decentralization effort. Several variables that capture such conditions are detailed below.

Level of economic development of the river basin region measures the ability of the basin stakeholders to commit financial and other resources necessary to the decentralization process in addition to central government provision of support for the decentralization effort. Successful decentralization must include some degree of financial autonomy (Cerniglia, 2003; Musgrave, 1997).[3] Sustaining this financial autonomy often depends upon establishing some form of water pricing or tariffs, having the users obey such payments, and having the proceeds remain within or return to the basin to support the decentralization effort. *This in turn implies that basins that have a level of economic development which can sustain those resource commitments are (all other things being equal) more likely to achieve sustainable success in decentralization.*

Population density measures also the level of development of the basin. Basins with more population per unit of land face more development problems and are likely to be involved in reforms such as decentralization (Cerniglia, 2003). *We would expect that higher levels of population density is likely to lead to decentralization and to more successful decentralization*.

Initial distribution of resources among basin stakeholders affects the development of and the prospect for successful implementation of a decentralization initiative. On the one hand, extreme disparities in resource endowments among basin stakeholders can imperil decentralization success (Becker, 1983; Dinar, 2003). On the other hand (and less obviously), some inequality of initial resource endowments may facilitate action by enabling some stakeholders to bear the costs of taking a leadership role (Blomquist, 1988; Ostrom, 1990). Cerniglia (2003) used a similar argument that the more unequal the distribution of income, the more decentralized the public sector. Extreme inequality, however, may be detrimental or even derail the decentralization effort. *The relationship between level of inequality of resource endowments and successful decentralization is hill-shaped, with greatest positive impact at a certain level of inequality and lower or negative impacts at both lower and higher levels of inequality of resource endowment distribution.*

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[3] We should mention in this context the level of economic development of the nation as another possible variable explaining successful decentralization. However, unlike in Cerniglia (2003), where this variable is used to explain level of national fiscal decentralization efforts, or even in the case of water institutional reform in Australia (Musgrave, 1997), river basin decentralization does not necessarily occur on a national scale and thus it may be less appropriate to *a-priori* use economic development level of the nation to explain decentralization performance.

2.1.2. Characteristics of the decentralization process

Certain conditions or characteristics of the decentralization process itself may affect the prospects for successful implementation. Two necessary conditions of a decentralization initiative include (a) a devolution of authority and responsibility from the center, and (b) an acceptance of that authority and responsibility by the local or regional units. Whether (a) and (b) both occur will depend, in part, upon why and how the decentralization takes place.

Top-down, bottom-up, or mutually desired devolution characterize the decentralization initiative. In some cases, central government may have undertaken resource management decentralization initiatives in order to solve its own problems—e.g., to reduce or eliminate the central government's political accountability for policy failures and resolve budgetary crisis (Simon 2002). In other cases it is "bottom up" pressure from the stakeholders that leads to the decentralization (Samad, 2005). In still other cases, the decision to decentralize resource management to a lower and more appropriate level may have been the outcome of a process of mutual discussion and agreement between central officials and local stakeholders, each achieving their own goals. *All other things being equal, we anticipate that because decentralization initiatives require active basin-level stakeholder involvement, they are more likely to be implemented successfully under bottom up pressures and mutual agreement.*

Existing local-level governance arrangements contribute to continuation. Decentralization initiatives are more likely to be accompanied by active involvement of basin stakeholders if existing community-level (village, tribe) governance institutions and practices are recognized and incorporated in the decentralization process (Ostrom, 1990; Derman et al., 2000; Faguet, 2004)). This is mainly due to transaction costs (primarily in terms of time and effort) to basin stakeholders that are likely to be smaller than the transaction costs of having new sets of basin-level organizations. It is not to say that no new institutions will have to be created in order to achieve basin-scale management—in fact, new institutions will often be needed to promote communication and integrate decision making across communities within a river basin (Galasso and Ravallion, 2000). *All other things being equal, decentralization initiatives are more likely to succeed in gaining stakeholder acceptance if based upon, and constructed from existing traditional community governance institutions and practices.*

2.1.3. Characteristics of central government/basin-level relationships and capacities

Because successful decentralization requires complementary actions at the central government and local levels, other aspects of the central-local relationship can be expected to affect that success. Accordingly, our framework includes a set of political and institutional variables having to do with the respective capacities of the central government and the basin-level stakeholders, and with the relationship between them.

Local autonomy in institutional reform is the extent to which local communities can design and implement their own institutional arrangements. It is a key element to the success of decentralization. Successful implementation of decentralization is likely to be a function of that local autonomy, because implementation costs are closely associated with information that is better obtained at the local level, and because stakeholder involvement is expected to be greater in crafting their own institutions. However, as stakeholders create more institutional arrangements (particularly organizations and agencies), they incur greater transaction costs in maintaining them and coordinating their activities (Oechssler, 1997). *All other things being equal, we expect successful and sustainable implementation of decentralization initiatives more often in settings where local-level stakeholders are empowered to craft and modify institutional arrangements for resource management at the basin and sub-basin levels (including cross-jurisdictional arrangements)*.

Economic, political and social differences among basin users. In many countries, the distribution of political influence is a function of economic, religious, or other social and cultural characteristics. Yet, even if it were not for the connection between such characteristics and political influence, the characteristics themselves may affect implementation of decentralization initiatives through their independent effects on stakeholder communication, trust, and extent of experience in interdependent endeavors (Becker, 1983). *The greater and more contentious these distinctions, all other things being equal, the more difficult it will be to develop and sustain basin-scale institutional arrangements for governing and managing water resources*. [4] We

[4] It is important to add that these are empirical, not prescriptive, observations. Central government officials cannot make distinctions among basin-level stakeholders disappear. Nor should central government officials selectively apply decentralization policies only in relatively homogeneous settings.

should mention however, that Cerniglia (2003) showed that diversity in terms of religious homogeneity and ethno-linguistic homogeneity lead to more decentralized public sector.

Country governance structure impacts decentralization reforms including those in river basins. We hypothesize that federal countries will perform better in decentralization reforms because federal countries, which present a lower degree of centralization than unitary countries, have the fiscal and other decentralized policy regulations already in place (Cerniglia, 2003). *With all other things being equal, we would expect that decentralization in basins located in federal countries is more likely to succeed than in basins located in unitary countries.*

Adequate time for implementation and adaptation. Time is needed to develop, experiment and practice basin-scale institutional arrangements, to build trust among the parties involved; and also to translate resource management plans into observable and sustained effects on resource conditions. The relationship between time and success in water resource management is complicated. While we have already argued that adaptability is important, allowing response to changing conditions, time is important, too—changing institutions quickly because a new approach has not succeeded can simply erode stakeholders' willingness to commit their time and effort to the next reform. *A curvilinear relationship may exist, where successful implementation is less likely to be observed among decentralization initiatives that are very young, but is more likely among initiatives with longer periods. However, it is likely to taper off if basin-level arrangements have proved insufficiently adaptable over long periods*.

2.1.4. The internal configuration of basin-level institutional arrangements

Successful implementation of decentralized water resource management may also depend on features of the basin arrangements created by stakeholders and/or by the central government.

Presence of some basin-level governance institutions may be a necessary condition for successful decentralized water resource management. Basin-level governance—allowing stakeholders articulate their interests, share information, communicate and bargain, and take collective decisions—is essential to the ability of water users to operate at multiple levels of action, which is a key to sustaining successful resource preservation and efficient use (Ostrom, 1990). Basin-level water resource management (in other words, a decentralized system) is neither achievable nor sustainable without the establishment and maintenance of basin-level governance arrangements. *Because the existence of governance arrangements is a necessary,*

not sufficient, condition of successful resource management, we should not expect to find success everywhere we find basin-level governance institutions, but it would be more likely to find failure where they are absent.

Mechanisms for conflict resolution are needed to prevent disagreements from worsening. Resource users can and will disagree on many issues, including how well their interests are being represented and protected, how well the resource management program is working and whether it is time for a change, and on the distribution of benefits and costs. The success and sustainability of decentralized resource management efforts therefore also depend on the presence of forums for addressing conflicts. *All other things being equal, we would expect successful implementation of decentralized water resource management more likely in settings where forums for conflict resolution exist*.

2.1.5. General hypotheses

We will also infer several general hypotheses suggested by the decentralization literature. First, we will infer whether or not various decentralization process characteristics and performance differ between developed and developing countries. Mody (2004) suggests several reasons for such differences, including existing governance, capacity, and financial resources in developed countries. Second, we will also infer whether or not national wealth and basin wealth (see footnote 3) impact positively the performance of the decentralization process (Cerniglia, 2003). Third, we will infer whether or not the size of the basin affects both the process and the performance of the decentralization (Cerniglia, 2003). Finally, we will infer the hill shaped relationship of several dependent variables. Following Dinar and Dinar (2005), water scarcity level in a basin is expected to have a hill shaped relationship with low levels of scarcity and high levels of scarcity associated with lower decentralization performance levels. Based on our analytical framework, we will infer also the hill shaped relationships between variables representing distribution of endowments among basin stakeholders and the decentralization performance.

3. Data, variable construction, and analytical techniques

In order to infer the hypothesized impact of the above variables on the process and performance of river basin decentralization, we applied several statistical tests to data collected from 83 river

basins around the world (Figure 2). A survey instrument was developed and pre-tested on 25 river basin organizations (RBOs) prior to being modified, translated into English, Spanish, French and Portuguese and sent to a total of 197 known RBOs around the world that underwent decentralization. In addition to land mail and email venues, a website with the survey[5] was created to facilitate online responses. Data collection was completed after an iterative process of data entry and quality assurance reviews. Additional rudimentary statistical tests were undertaken to identify, verify and correct outliers.

The questionnaires were filled by staff from the basins. As such, answers to questions that address performance could be seen, a-priori as subjective, and potentially biased. However, given the length of the decentralization process (up to 36 years), staff had been replaced and thus we are not concerned about biased responses to performance of decentralization. In addition, we are comfortable with our sample size, with the various measurements of decentralization success, and with the use of a variety of statistical methodologies to best explain the responses. And finally, as correctly indicated by Alderman (2002) local authorities appear to both have access to information that is not easily captured in surveys.

Questionnaires from 103 RBOs (52% response rate) were returned. After reviewing all responses and completeness and accuracy of data, questionnaires of 20 basins were removed from the dataset because they could not be corrected. Therefore 83 responses from basins in 27 countries comprise the final dataset (Table 1).[6, 7]

3.1. Variable Construction

Our questionnaire consisted of 47 questions and 226 primary variables. A description of the variables included in the analysis appears in the Annex to the paper, and a detailed explanation

[5] www.worldbank.org/riverbasinmanagement

[6] To our knowledge this is the largest dataset of information about decentralization of river basin organizations worldwide that is currently in existence.

[7] Transboundary riverbasin management processes are significantly different from similar processes in national basins. For this reason, a decision was taken to not include transboundary basins in the analysis. Three basins that could be considered transboundary were included, however, because they were either mostly contained in one country or featured a river basin organization that had been developed only in one country. We conducted separate analyses for the entire dataset and for the dataset consisting on the 81 domestic basins, but results are identical, and not presented.

and description of each variable is provided in Annex 3 in Dinar et al (2005). Some of the variables in our data set are naturally correlated to each other. We conduct several Principal Component (PC) Analyses in order to capture the information these variables provide and prevent possible multicollinearity, by combining a set of primary variables into one inclusive PC variable in our estimated relationships. We also used several primary variables to create indices to reflect values that are better expressed on a relative rather than on an absolute scale.

4. Empirical Analysis

This section presents the general framework for the econometric analysis of the data with empirical specifications adjusted to the variables that were constructed.

4.1. The Empirical Models

We are interested in two types of relationships. The first relationship explains certain aspects of the decentralization process. The second relationship explains level of success/progress of the decentralization process.

The set of equations used in the estimation of the first relationship takes the form:

$$\underline{\boldsymbol{P}}=g(\underline{\boldsymbol{C}}, \underline{\boldsymbol{R}}, \underline{\boldsymbol{I}} \mid \underline{\boldsymbol{X}}), \quad (1)$$

where

$\underline{\boldsymbol{P}}$ is a vector of characteristics of the decentralization process;

$\underline{\boldsymbol{C}}$ is a vector of contextual factors and initial conditions;

$\underline{\boldsymbol{R}}$ is a vector of characteristics of central government/basin-level relationships and capacities;

$\underline{\boldsymbol{I}}$ is a vector of internal configuration of basin-level institutional arrangements;

$\underline{\boldsymbol{X}}$ is a vector of 'other' variables, identified as necessary.

A general relationship for decentralization success/progress, using the analytical framework developed above is as follows:

$$\underline{\boldsymbol{S}}=f(\underline{\boldsymbol{C}}, \underline{\boldsymbol{P}}, \underline{\boldsymbol{R}}, \underline{\boldsymbol{I}} \mid \underline{\boldsymbol{X}}), \quad (2)$$

where $\underline{\boldsymbol{S}}$ is a measure of performance of the decentralization in the river basin.

Note that equations (1) and (2) can also be estimated as a system, due to the fact that $\underline{\boldsymbol{P}}$, which is a dependent variable in equation (1), serves as an independent variable in equation (2), thus serving as the instrumental variable of the system. While we believe that variables in $\underline{\boldsymbol{P}}$ and $\underline{\boldsymbol{S}}$ in (1) and (2) may form a system, we have no reason to assume that some $P \in \underline{\boldsymbol{P}}$ and $S \in \underline{\boldsymbol{S}}$ are being determined within the system. Rather, all P and S variables are assumed to be determenied outside of this system and not to be correlated with the error terms of (1) and (2).

The equation system we estimate is:

$$\begin{cases} \underline{\boldsymbol{P}} = e(\underline{\boldsymbol{C}}, \underline{\boldsymbol{R}}, \underline{\boldsymbol{I}} \mid \underline{\boldsymbol{X}}) \\ \underline{\boldsymbol{S}} = h(\underline{\boldsymbol{C}}, \underline{\boldsymbol{P}}, \underline{\boldsymbol{R}}, \underline{\boldsymbol{I}} \mid \underline{\boldsymbol{X}}) \end{cases} \tag{3}$$

with all parameters having the same meaning as in equations (1) and (2).

We propose several specifications for the functional forms of (1) and (2), depending on the nature of the variables $\underline{\boldsymbol{S}}$ and $\underline{\boldsymbol{P}}$ used. One possible way to measure success is by using a dichotomous variable that takes the value 1 when decentralization was initiated and 0 when no decentralization took place in spite of government intent. A second way of describing success is to measure normatively the extent of achieving several important original goals of the decentralization process. In this case the various RBOs have been ranked on a scale $\underline{\boldsymbol{S}}=[\underline{s}, \bar{s}]$, measuring the decentralization success, which allows $\underline{\boldsymbol{S}}$ to get a range of (integer) values. A third way of measuring progress of decentralization is by comparing performance between post- and pre-decentralization periods (Faguet, 2004). Performance variables may include: level of participation, local responsibility, financial performance, economic activity etc. Using this definition, $\underline{\boldsymbol{S}}$ becomes a continuous variable. Each of these performance variables is measured on different scales and actually comprised of various sub-variables. A t-test analysis of 'before' and 'after' levels for each sub-variable as well as a PC analysis for each group have been performed.

4.2. Empirical Specifications of the Decentralization Process and its Performance

We turn now to the hypothesized relationships concerning characteristics of the decentralization process (equation (1)). Several variables (for definitions see Annex) could help shed light on the decentralization process. The length of the decentralization process, *Yrs Decentralization*, the transaction costs of the process, measured by several variables such as *Instit Dismantled*, *Instit*

Creaed, *Politcal Cost*, and the level of involvement of the stakeholders, *WUAs Involvement*, will be used. We employ different estimation procedures based on the characteristics of the dependent variable of each equation.

We identify several variables that could measure decentralization success and progress. We use the variables *Success Obj1* to reflect achievement of various goals the decentralization process was aimed to achieve. A GLM procedure is applied because the dependent variable is truncated varying between 0 and an upper value. We also construct several additional variables that measure decentralization progress: *Problems Aftr*, *Incremental Tasks*, *Incremental Improvement*, and *Improved Responsibility* (See Annex), that are not truncated and thus an OLS estimation procedure is used for the estimations of their relationship with other independent variables.

Finally, we estimate two equation systems to capture the process-progress interaction. The dependent variable for decentralization process is *WUAs Involvement* in both systems. The dependent variables for decentralization progress are *Problems Aftr* and *Improved Responsibility*, in System 1 and 2, respectively.

4.3. Channels of Impact

Once we estimate the various relationships of decentralization process and progress, we can capture the total impact of a marginal change in each of the explanatory variables on the performance of the decentralization process. We create the performance equation, based on the system (3), by substituting ***P*** in equation (1) into equation (2) and obtaining equation (4),

$$S = h(C, e(C, R, I, X), R, I, X) \tag{4}$$

Then, by applying the chain derivative rule, we obtain for each dependent variable a path through which it impacts the decentralization performance. The values $\frac{\partial S}{\partial m}$ (m being any dependent variable) in equations (5)-(8) measures the total impact on decentralization performance of marginal change in m.

$$\frac{\partial S}{\partial C} = \frac{\partial S}{\partial h}\left[\frac{\partial h}{\partial C} + \frac{\partial h}{\partial e}\frac{\partial e}{\partial C}\right] \tag{5}$$

$$\frac{\partial S}{\partial R} = \frac{\partial S}{\partial h}\left[\frac{\partial h}{\partial e}\frac{\partial e}{\partial R} + \frac{\partial h}{\partial R}\right] \tag{6}$$

$$\frac{\partial S}{\partial I} = \frac{\partial S}{\partial h}\left[\frac{\partial h}{\partial e}\frac{\partial e}{\partial I} + \frac{\partial h}{\partial I}\right] \tag{7}$$

$$\frac{\partial S}{\partial X} = \frac{\partial S}{\partial h}\left[\frac{\partial h}{\partial e}\frac{\partial e}{\partial X} + \frac{\partial h}{\partial X}\right] \tag{8}$$

Given our estimates of the coefficients of the various dependent variables in the system equations we are able also to quantify the overall impact of each variable on the performance level of the decentralization process.

5. Results

The distribution of the RBOs in our dataset reflects actual decentralization reforms that took place in the various continents, with the Latin America continent leading in that respect. Of the 83 basins, 51 are located in developing countries and 43 are in countries with unitary regimes.[8]

An important phase in our variable construction was the Princpal Component analysis. The eigenvectors of the first principal components used in the creation of the principal component variables are presented in table 6 in Dinar et al. (2005). These eigenvectors explain between 25 and 99 percent of the standardized variance among the primary variables. The primary and constructed PC variables employed in the analysis, and their descriptive statistics, are presented in the Annex of this paper.

5.1. Inference of General Hypotheses

The results of the models that tested our general hypotheses indicate no significant difference between developing and developed countries in the equations describing both process and performance of the decentralization process. The physical size of the basin, the wealth of the nation, and the wealth of the basin were not found significant in explaining differences in the

[8] This distribution reflects the efforts, especially in Latin America in recent years, to implement decentralized river basin water resource management. Basin management is now being pursued throughout Europe as well, as EU members and candidate states attempt to comply with the Water Framework Directive.

decentralization process and its performance. Furthermore, the hypothesized hill shaped behavior of the variables *Scarcity1* and that of the basin resource distribution, measured by *Sector Use Shares* could not be inferred. These results are therefore not presented, but can be obtained from the authors upon request.

5.2. Is Water Managed indeed at a Lower Level (Comparing Before and After Results)

We assess progress of decentralization by comparing levels of several sets of responsibility/management indicators before and after decentralization, using a two-tailed t-test. Water management decisions are made at roughly local, basin, state, and federal levels. We would expect that more decisions are made at lower levels after decentralization compared with before decentralization. We refer to the share of management decisions that were made at various levels and compare these shares before and after decentralization. The management decisions relate to general administration of the basin; infrastructure investment and management; water quality monitoring and enforcement; and setting water quality standards (Table 2). An additional indicator compared the level of responsibility (local, basin, state, or federal) for water rights, water allocation, modeling-forecasting, monitoring, and tariff collection before and after decentralization (Table 3).

As expected, after decentralization the share of decisions made at federal and state levels decreased and the share of decisions at local level increased significantly in most cases (Table 2) in all categories (administration, infrastructure financing, water quality standard setting and enforcement), showing a greater involvement of local stakeholders. When shares of state level involvement increased, this change was not significant. In the case of responsibility shift (Table 3), we found that in all management items, responsibility was taken over by lower level decision makers in the process of decentralization. However, on average, for none of the items analyzed the responsibility reached local or basin levels after decentralization. In addition, water allocation activities have not changed significantly compared to the other three activities in Table 3. Our interpretation is that water allocation is the most politically important activity most fraught with vested interests, and therefore, most difficult to decentralize.

5.3. The Decentralization Process

We estimated several relationships that could explain the characteristics of the decentralization process in terms of its length, complexity and participation of stakeholders. We include several

equations representing various aspects of the decentralization process in Table 4. The equations incorporate variables measuring the creation and dismantling of institutions, the involvement of water user groups, the political cost of the decentralization process and the length of the decentralization process. Generally, the signs of the explanatory variables used in the analysis are consistent with our expectations. Fit and significant tests of the models suggest that all are significant at the 5 percent level (and better) in explaining the variation in the level of the various decentralization process indicators.

Certain variables, such as the percentage of users in the irrigation, industrial, and urban sectors that pay their tariffs (*User Pay*), share of surface water in the available water resources in the basin *(Share SW*) and governance of the RBO (*Governing Body*) are significant and their signs are as expected in all equations.[9] The variable *Scarcity1* (i.e. ratio between rainfall and evapotranspiration) has a significant negative impact on the length of the decentralization process with basins facing higher scarcity[10] completing their decentralization processes faster than basins with more abundant water.[11] The variable *Forms Dispute1* (i.e. number of forums that are available to hear/solve disputes) was significant in stimulating involvement of user groups in the process. The *Regime* variable, with federal governance as benchmark, was negative and significant in all estimates, indicating that basins in federal countries have scored higher on various decentralization process indicators.

5.4. The Decentralization Performance

We present the estimated decentralization performance equations, using different estimation procedures and sets of explanatory and dependent variables (Table 5). The estimated model equations display a robust set of results that support our hypotheses. Fit and significant tests of

[9] Given the nature of the 5 dependent variables we expect to have different signs of the same explanatory variable, depending on the equation.

[10] Notice that the lower the ratio of rainfall to evaporation, the higher the scarcity, so a negative sign of the scarcity coefficient in the equation reads as a higher level of scarcity.

[11] For example, scarcity forced the states sharing the Colorado River Basin to back away from their individual management of the water in the basin and look into a basin-wide management arrangement. This observation doesn't contradict our findings, as we asserted that the lowest appropriate level for decentralization of water resource management varies by the cases.

the models suggest that all are significant at the 5 percent level (and better) in explaining the variation in the level of performance of the decentralization.

The main results in Table 5 suggest that the higher the share of the basin management budget that is provided from governmental sources external to the basin the higher is the level of the decentralization success. Also, as expected, the level of the decentralization success is higher with an increase in the share of users that pay their tariffs. These two finding suggest that success is associated with a combination of local self funding and central government support. The decentralization objective variable also suggests that the more comprehensive the set of objectives that decentralization reforms were supposed to address, the higher the level of success. In addition, top-down initiation of decentralization reform was detrimental for success of the decentralization process. The *Regime* variable, was negative and significant in all estimates, indicating that basins in federal countries have scored higher on various decentralization process indicators. Basins in countries with unitary regimes exhibited inferior decentralization performance. Finally, water scarcity level in the basin positively affected the success of the decentralization.

5.5. The Interaction between the Decentralization Process and its Level of Performance

In order to assess the impact of the decentralization process on the level of success, we estimated a couple of two-stage equation systems. The first equation in each system depicts the decentralization process, as was described in the previous section, and the process variable is included as an instrumental variable in an equation that describes the decentralization performance. Table 6 presents the results of a 2-SLS estimation procedure. The value and direction of the coefficients are as expected and not significantly different than those presented for the single equation estimates (in tables 4 and 5). Both systems are significant at a 1 percent, and the system Adjusted-R^2 is 0.65 and 0.24 for system 1 and 2, respectively.

5.6. Channels of Impact

The channels-of-impact analysis is presented in Table 7. We refer to decentralization policy variables (e.g. *Budget Spnt, Governing Body, Main Objectives*), and contextual variables (*Scarcity1, Share SW*) and calculate impact of each variable on the decentralization performance in each equation system. It is apparent that all variables perform very similarly across the two systems, except for *Exist User Groups* and *WUAs Involvement* that have an opposite impact in

system 1 and 2, respectively. An important finding is that the *Main Objectives* and the *Budget Spnt* policy variables have the highest impact (the former in both systems, and the latter in the second system), surpassing the contextual variables *Scarcity1* and *Share SW*. These findings imply that appropriate planning of the decentralization and its implementation policy could affect the level of certain variables (such as *Main Objectives*) while other variables (such as *Share SW*) are not affected by policy. However, even in the latter case, careful policy could address issues associated with impact of *Share SW* and made it as effective as possible.

6. Conclusion and Policy Implications

The results of our econometric analyses suggest that both the process and the performance of decentralization in the sample basins are supported by our analytical framework and well explained by the set of independent variables we identified. Several of these variables provide a robust explanation regardless of the equation selected and the estimation procedure used. The results can also provide useful insights for policy makers who consider decentralization of river basins but have little or no experience.

The variables referring to the contextual factors and initial conditions significantly affect the nature of the decentralization process and its performance. The starting point and level of the natural resource endowments in the basin matter a great deal; thus, where one stands dictates how one should implement the reform and how one may end up. However, rich and well endowed basins do not necessarily have an advantage over less endowed basins. Stressed resource conditions and the presence of multiple major problems can be stimulants to effective action and not only obstacles. For example, water scarcity is an important variable that affects the process as well as the performance of decentralization. As water in the basin is less abundant the incentives are greater for an effective decentralization process and a more successful outcome. Scarcity is positively associated with several aspects of the decentralization process and its performance. Indeed, the basin water scarcity variable is the most robust variable in the various analyses we conducted. The presence of scarcity may therefore be a stimulus to reform, uniting the stakeholders in the basin. This fits nicely with the notion of 'Scarperation' (Dinar and Dinar, 2005), that is, scarcity is also an incentive for cooperation among the parties sharing an international river basin. In addition to water scarcity, the number and level of severity of water resource problems (e.g., quality) present in a basin prior to decentralization is an important

factor in initiating effective decentralization reforms. The more ambitious and nearly comprehensive the decentralization effort, and the greater the problems users faced, the more likely they were to see the effort as worthwhile and effective.

The results associated with the variables affiliated with the characteristics of the decentralization process suggest that indeed political economy plays a role in the decentralization process and affects its performance level, through both a need for compromise and increased transaction costs. Sectorally diverse and 'crowded' basins do not necessarily have to face higher political cost and lower levels of reform performance, if appropriate mechanisms such as forums for dispute resolution and a coherent reform agenda are put in place. Another important conclusion is that a longer decentralization process is not necessarily a negative outcome. Longer reform processes may yield some benefits such as better understanding and communication among stakeholder groups, higher rates of compliance with tariffs, and better-established dispute resolution practices. Also, dismantling of institutions during the decentralization process contributes to the performance of the decentralization process. On the other hand, a decentralization process characterized by protracted political struggle leaves a negative impact on the decentralization performance.

Thus, it appears that complexity and conflict are distinct characteristics that work in opposite ways. The mere presence of a larger number of organizations within a river basin, and the sheer length of time a decentralization reform takes, do not appear to be substantial negative factors. On the other hand, highly conflicted decentralization processes are associated with poorer performance, and some elimination of previously existing institutional arrangements may be a positive factor. Thus, what matters is not so much how complicated or lengthy the process is, but the degree of conflict and the ability to make organizational changes along the way. As a consequence, the greater the political transaction costs associated with the decentralization process, the smaller the reported improvement between "before" and "after" decentralization. The longer the decentralization process took, the greater the extent of reported improvement between "before" and "after" decentralization.

Variables describing government-basin relationships, such as budget and funding by government agencies and the initiation of the reform process, are also consistent with our expectations. The results suggest that continued central government financial support is often

important and needed.[12] On the other hand, initiation of the decentralization process by central governments may be counterproductive and end in lower levels of reform performance. In conclusion, government support for decentralization is beneficial, as long as it allows the stakeholders to initiate and lead the reform process.

Financial dimensions of decentralized river basin management are therefore both important and complex: success is associated with central government support *as well as* water user financial responsibility, and with revenues generated within the basin remaining in the basin. Thus, it is the *combination* of financial responsibility (on the part of water users), financial autonomy (basin revenues remaining in the basin), and central government support that is associated with success, and not necessarily one element alone. This is consistent with our analytical framework, which hypothesized that a configuration of factors that included a supportive but not controlling role for the central government, and responsibility but not complete independence for the water users in the basin, would be associated with successful implementation of decentralization reforms.

Our variables concerning basin-level institutional arrangements (such as user group presence, and budget sources and use) indicate the importance of water user organizations in setting the outcomes of decentralization reforms. Involvement of such groups may make the process longer, but as noted, longer does not necessarily mean worse. The results also provide additional support to the old 'mantra' that budgets that go back to the source have a positive impact on stakeholder involvement and system performance. One interesting result is that basins with higher budget per capita are not necessarily more successful, reinforcing our findings above that success in river basin management is not necessarily confined to well-endowed basins.

The analysis in this paper can be useful in planning and designing decentralization of river basin management in that some of the variables involved in the process, have greater effects on the decentralization process and performance than others. The share of the budget of the

[12] River basin organizations with higher percentages of their budgets from external governmental sources (such as the local and federal governments) benefit from better stability and support and it shows in the performance of the decentralization process. However, the same relationship does not hold for the budget share contributed by other outside sources.

basin authority that is spent in the basin and the set of objectives associated with the decentralization process are the most important process-related variables, i.e., with the highest marginal impact values. Since these are two variables that policy makers can affect in the design process, we paid special attention to them. In addition there are contextual variables, such as the level of water scarcity in the basin and the share of surface water in the water resources used in the basin, with important effects that policy needs to take into account even if those matters are not within policy makers' control.

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Table 1: The Distribution of Responses by Continents

Continent	Questionnaires sent	Responses	Eliminated	**Retained in the data set**
Africa & Middle East	18	14	2	12 (66)[a]
Latin America	118	37	2	35 (30)
North America	5	5	0	5 (100)
East Asia-Pacific	7	7	3	4 (57)
Europe	49	40	13	27 (26)
Total	197	103	20	83 (42)

[a] In parentheses are percent of retained questionnaires from the number that were sent.

Table 2. Share of Decision Making at Various Levels before and after Decentralization:

Activity	Before	After	t-value
1. Administrative issues			
Basin level	0.06	0.32	4.32***
State level	0.12	0.10	-1.08
Central government level	0.37	0.17	-5.68***
2. Infrastructure financing			
Basin level	0.02	0.08	3.17***
State level	0.14	0.17	2.82***
Central government level	0.45	0.33	-3.64***
3. Water quality enforcement			
Basin level	0.03	0.23	6.02***
State level	0.12	0.18	2.13**
Central government level	0.44	0.14	-6.20***
4. Setting water quality standards			
Basin level	0.00	0.15	4.77***
State level	0.11	0.15	1.57*
Central government level	0.53	0.35	-4.70***

Note: *** $p<0.01$; ** $p<0.05$; * $p<0.10$.

Table 3: Shift in Responsibility of Various Functions before and after Decentralization

Responsibility item	Before	After	t-value
Water allocation	2.43	2.86	1.78*
Water modeling and forecasting	2.21	3.28	2.98***
Water quality monitoring and enforcement	2.09	2.85	3.15***
Water tariff collection and enforcement	1.10	1.62	3.11***

[a]1=federal, 2=national agency, 3=state/provincial agency,4=regional organization, 5=local government, 6=river basin organization.

Note: *** $p<0.01$; ** $p<0.05$; * $p<0.10$.

Table 4: Features of the Decentralization Process

Estimation Procedure[a]	OLS	POISSON	GLM
Independent Variable	WUAs Involvement	Yrs Decentralization	Instit Dismantled
Intercept	0.139 (1.16)	2.407*** (2.85)	0.321** (1.99)
Budget Basn			1.456*** (7.08)
Budget Spnt	-0.054 (-0.98)		-0.497*** (4.45)
Budget Srcs	-0.204*** (-2.49)		
User Pay		0.025*** (4.39)	-0.012*** (-8.91)
Forms Dispute1	0.056** (2.26)		
Governing Body	-0.029* (-1.17)	-0.461*** (-3.50)	
Main Objectives		0.268 (0.59)	
Scarcity1	-0.0001 (-0.25)	-0.102*** (-3.61)	-0.005*** (-4.23)
Sector Composition	-0.004 (-0.11)		0.179*** (2.04)
Share Sw	0.366*** (3.77)		
Types Disputes			-0.063*** (-2.76)
Regime	-0.171*** (-2.47)	-0.758*** (-2.79)	-0.097 (-0.64)
Log Pseudolikelihood		-306.18	-72.92
F-test	54.48***		
Adjusted-R^2	0.465		
Wald Chi-square		23.09***	
Pseudo-R^2		0.344	

Note: *** p<0.01; ** p<0.05; * p<0.10.

[a]Estimation procedure explaining *Yrs Decentralization* will use TOBIT as values are continuous between 0-100. Estimation procedures explaining *Instit Dismantled*, *Insit Created*, and *Political Cost* will use GLM as these are string variables. And estimation procedures explaining *WUAs Involvement* will use OLS as values are continuous and greater than 100.

Table 5: Estimated Decentralization Performance Equations

Dependent Variable	Success Obj1	Problems Aftr	Improved Responsibility	Improved Responsibility	Incremental Tasks	Incremental Tasks	Incremental Imprvement
Estimation Procedure	GLM	OLS					
Intercept	-0.305 (-0.12)	2.088*** (2.52)	0.056 (0.06)	0.299 (0.31)	0.146*** (2.64)	0.135*** (2.41)	0.191** (1.86)
Budget Extr	8.744*** (3.50)						0.255 (1.11)
Budget Spnt		0.262 (0.82)	2.096*** (2.79)	1.886*** (2.55)			
Budget Srcs		-0.280 (-0.66)					
Exist User Groups		0.517*** (2.42)					
Forms Dispute1	1.446** (2.10)						
Governing Body		-0.032 (-0.33)					
Instit Dismantled					0.101*** (2.75)	0.101*** (2.72)	0.165** (1.94)
Main Objectives	2.809*** (2.28)	0.578*** (2.62)	1.376*** (2.47)	1.181** (2.10)			
Minor Objectives	0.147** (1.59)						
Political Cost			-0.817** (-1.84)	-0.869** (-1.91)	-0.165** (-1.89)	-0.166** (-1.89)	-0.240* (1.55)
Problems Bfr		0.686***					

		(5.83)					
Scarcity1	-0.019** (-1.80)	-0.0005 (-0.31)	-0.014*** (-2.44)	-0.010** (-2.31)	-0.0007*** (-3.18)	-0.0007*** (-2.97)	-0.001*** (-3.01)
Sector Composition	-2.426*** (-2.34)						-0.093 (-0.77)
Share SW	-4.055** (-1.82)		1.721* (1.59)	1.522 (1.43)			
Types Disputes			-0.204 (-1.46)	-0.161 (-1.11)	0.022** (2.35)	0.025*** (2.53)	
Yrs Decentralization		0.035*** (2.56)					
Pop Density				2.6E-06* (1.70)		5.8E-07*** (4.39)	
Regime		-0.790*** (-2.54)			-0.177*** (-3.01)	-0.182*** (-3.03)	-0.212** (-2.19)
F-test		12.35***	4.47***	15.84***	4.03***	6.11***	2.69**
Adjusted R^2		0.485	0.220	0.193	0.311	0.320	0.232
Log Likelihood	-271.69						

Note: *** p<0.01; ** p<0.05; * p<0.10.

Table 6: Results of 2SLS Estimated Equation System of Decentralization Process-Performance

	System 1		System 2	
	WUAs Involvement	Problems Aftr	WUAs Involvement	Improved Responsibility
Constant	0.114 (0.66)	2.53*** (2.71)	0.175 (1.29)	-0.345 (-0.28)
Budget Spnt	-0.051 (-0.70)	0.064 (0.18)	-0.060 (-0.88)	2.425*** (3.09)
Budget Srcs	-0.203*** (-2.58)	-0.806 (-1.41)	-0.219*** (-2.85)	
Exist User Groups		0.641*** (2.64)		
Forms Dispute1	0.062** (2.21)		0.067*** (2.49)	
Governing Body	-0.025 (-1.24)	-0.065 (-0.72)	-0.025 (-1.36)	
Main Objectives	-0.067 (-1.42)	0.526** (2.29)	-0.059 (-1.30)	1.199** (2.06)
Political Cost			0.065** (2.03)	-0.883** (-2.17)
Problems Bfr	0.015 (0.93)	0.743*** (6.63)		
Scarcity1	-8.74E-06 (-0.01)	-0.001 (-0.79)	-0.0001 (-0.13)	-0.009** (-2.24)
Sector Composition	-0.017 (-0.45)		-0.009 (-0.25)	
Share SW	0.357*** (3.98)		0.329*** (3.91)	1.251 (0.85)
WUAs Involvement		-2.03* (-1.77)		0.799 (0.30)
Yrs Decentralization	0.001 (0.30)	0.035*** (2.38)	0.002 (0.56)	0.012 (0.33)
Regime	-0.184*** (-2.70)	-1.311*** (-2.93)	-0.192*** (-2.90)	-0.779 (-0.64)
System F-test	22.22***		3.95***	
System Adjusted-R^2	0.648		0.237	

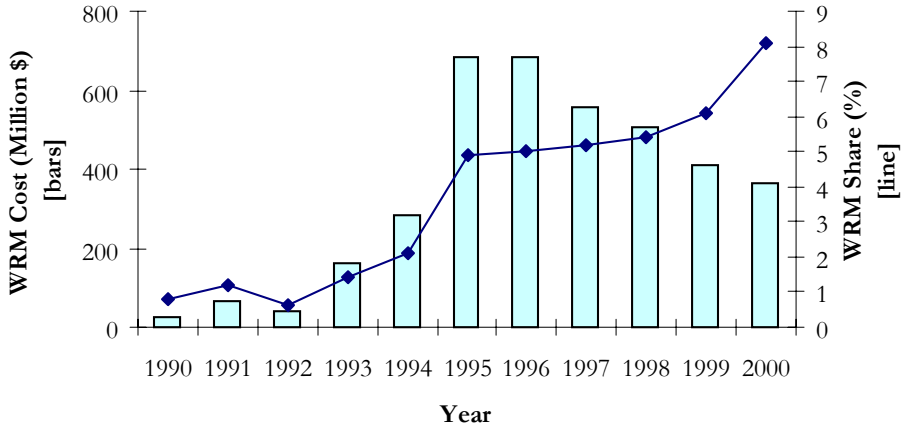
Note: *** p<0.01; ** p<0.05; * p<0.10

Table 7: Channels of Impact of Main Variables (absolute values)[a]

Variable	Total impact on *Problems After* in System 1	Total impact on *Improved Responsibility* in System 2
Budget Spnt	-4.87×10^{-2}	2.42
Governing Body	-6.58×10^{-2}	-3.00×10^{-4}
Main Objectives	5.23×10^{-1}	1.20
Scarcity1	-1.00×10^{-3}	-9.00×10^{-3}
Share SW	1.24×10^{-2}	1.25

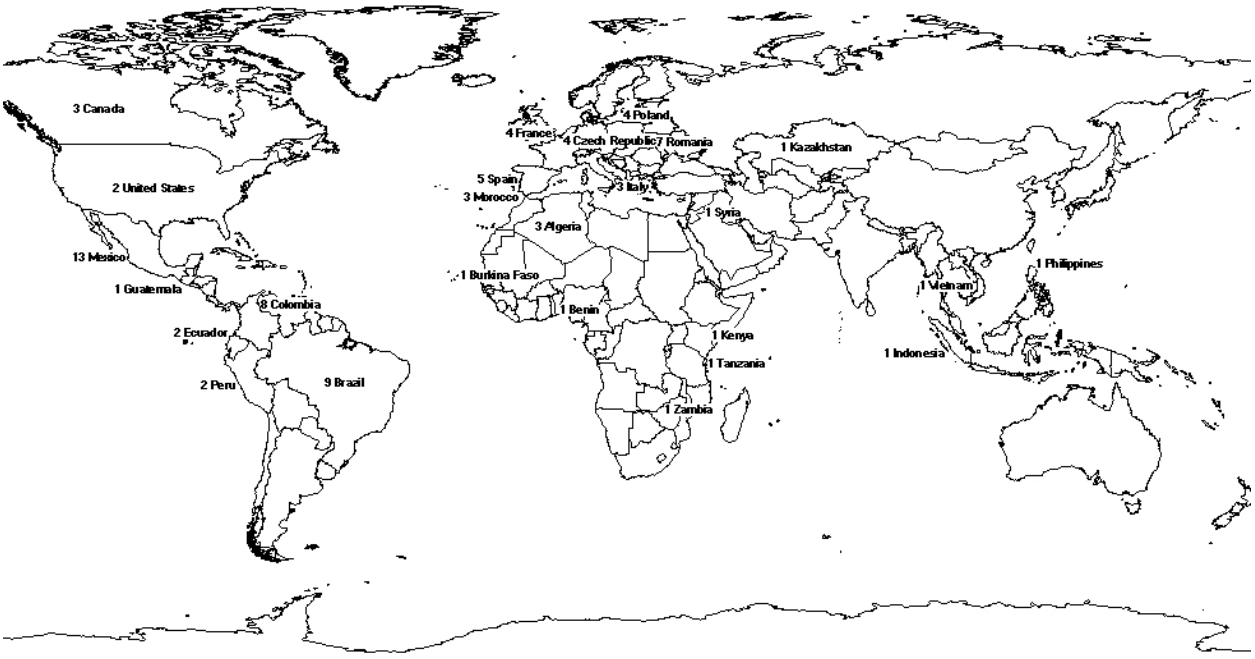
[a]Calculations based on data in Table 6 and on equations [5]-[8] in the text.

Figure 1: Cost and Share of Decentralization Investment Components in Water Resource Projects of the World Bank (1990-2000, current values)



Source: http://esd.worldbank.org/coredb/reports/Wa/Region_rpt.cfm

Figure 2: Countries and Number of River Basins in the Analysis



Note: the value next to the country name is the number of river basins in the dataset.

Annex: Variables used in the analysis (In parentheses: Mean, Standard deviation, min[13], max); [In brackets: expected impact sign on process; on performance].

Budget Basn=V182.[14] The share of the basin's budget obtained from basin stakeholders. (0.356, 0.391, 0.000, 1.000); [+;NA].

Budget Extr=V180. The share of the basin's budget allocated by external (government) agency. (0.190, 0.328, 0.000, 1.000); [NA;+].

Budget Per Cpita=V179/V11. The budget per capita in the basin. (0.292, 2.658, 0.000, 24.213); [+;+].

Budget Spnt=V184+V185+V186+V187. The share of the budget that is spent in the basin and not returned to external governments. (0.287, 0.474, -0.267, 1.370); [-;+].

Budget Srcs=**PC**(V180, V182, V183).[15] Share of budget from sources other than Government and Basin stakeholders. (-0.115, 0.413, -0.713, 0.710); [-;-].

Exist User Groups=**PC**(V163, V164, V165). Existence of irrigation, industrial and domestic user groups (measured as individually dichotomous variables) in the basin. (0.871, 0.783, 0.000, 1.731); [+;+].

Forms Dispute1=V44. Number of forums that are available to hear/solve disputes. (2.241, 1.265, 0.000, 4.000); [+;+].

Governing Body=V31. Higher values express more centralization: 5=Federal, 4=State Authority, 3=State owned company, 2=Regional Authority, 1=Regional Board/Council/Committee. (3.566, 1.768, 0.000, 5.000); [-;-].

Improved Responsibility=**PC**(V146-V140, V147-V141, V148-V142, V149-V143, V150-V144). The difference between 'after' and 'before' decentralization regarding 5 types of management responsibilities ranging between federal to basin level. (1.466, 3.639, -8.294, 9.217); [NA;NA].

Incremntal Improvement=**PC**(V91-V83, V92-V84, V93-V85, V94-V86, V95-V87, V96-V88). The incremental improvement in various issue problems in the basin between 'before' and 'after' decentralization. (0.104, 0.518, -4.162, 0.728); [NA;NA].

Incremntal Tasks=**PC**(V118-V98, V199-V99, V122-V102, V123-V103, V126-V106, V127-V107, V130-V110, V131-V111). The incremental change in 8 variables related to tasks at local and basin-level management between 'before' and 'after' decentralization. (0.128, 0.371, -2.671, 0.762); [NA;NA].

Instit Created=V36. Number of new institutions that had to be created in the decentralization process (1.542, 1.262, 0.000, 3.000); [NA;NA].

Instit Dismantled=V35. Number of existing institutions dismantled in the decentralization process (0.627, 0.837, 0.000, 3.000); [NA;+].

Main Objectives=**PC**(V19, V20, V21). The 3 main objectives of the RBO-conflict resolution, flood control, and water scarcity improvement. (1.008, 0.692, 0.000, 1.731); [+;+].

Method Creation=V33. The way the RBO was created (N/A=0, Bottom Up=1, and Top Down=2). (1.193, 0.903, 0.000, 2.000); [-;-].

Minor Objectives=**PC**(V22, V23, V24). The 3 minor objectives of the RBO-a combination of a set of 25 possible minor objectives. (6.208, 8.791, 0.000, 33.972); [+;+].

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[13] PC variables may have negative minimum values due to the process of their estimation

[14] Vxxx is the variable number that can be found in Dinar et al. (2005).

[15] PC=Principal Component variable.

Politcal Cost=V37. The political/transaction cost of the decentralization process via the creation of new institutions (0 = none, 1=Low, …, 5=high). (0.494, 0.942, 0.000, 5.000; [+,-]).
Pop Density=V2/V10. persons per square kilometer. (6567, 52970, 0.127, 480,000); [NA;+].
Problems Aftr=**PC**(V91, V92, V93, V94, V95, V96). The composite success of decentralization (No response=1, Situation improved=4, Same situation=3, Situation worsen=2. (5.837, 1.524, 2.334, 8.967); [NA;NA].
Problmes Bfr=**PC**(V83, V84, V85, V86, V87, V88). The composite level of problems in several domains: flooding, water scarcity, environmental quality, water conflicts, land degradation, development issues, measured on a scale of 1-4, with 4 being severe problems. (6.871, 1.823, 0.000, 9.750); [+;+].
Regime=Country's regime (Dummy variable: Federal=0, Unitary=1). (0.506, 0.503, 0, 1); [-;-]
Scarcity1=V13/V14. The ratio between rainfall and evapotranspiration [millimeter/millimeter]. (5.056, 27.965, 0.000, 246.679); [-;-].
Sector Composition=**PC**(V58, V59, V60, V61, V62). The composition of the subsectors in the basin—irrigation, industry, domestic, hydropower, environment, which expressed as Y=1 if the sector exist, and N=0 if the sector doesn't exist in the basin. (1.257, 0.793, 0.000, 2.183); [?,-].
Sector Use Shares=**PC**(V66, V67, V68, V69, V70). The distribution of water use shares of the five main water using sectors-irrigation, industry, domestic, hydropower and environment. (0.299, 0.768, -0.425, 6.609); [+;+].
Share SW=V75. The share of surface water in the available water resources in the basin. (0.434, 0.381, 0.000, 1.000); [+,+].
Success Obj1=**PC**(V25, V26, V27, V28, V29, V30). The integrated level of success of the three main decentralization objectives and the other 25 minor objectives, each measured on a scale of 1-5 with 5 indicating high level of success. (3.540, 7.814, 0.000, 63.510); [NA;NA].
Types Disputes=V46. Main types of disputes/issues that usually need resolving (4.207, 2.934, 0.000, 9.000); [-,?].
User Pay=**PC**(V169, V170, V171). The percentage of users in the irrigation, industrial, and urban sectors that pay their tariffs. (2.084, 13.990, 0.000, 127.886); [?;+]
WUAs Involvement=V47. The degree of WUA involvement and participation, expressed as a continuous variable on a scale between 0-100. (0.26, 0.36, 0.000, 1.000);[NA;+/-].
Year Creation=V18. The year in which the RBO was created. (1985.229, 18.486, 1926, 2002), [-;+/-].
Yrs Decentralization=V17. The length of the decentralization process. (2.711, 7.547, 0, 36); [+;+].

Comments:
NA means not applicable because it was not used as an independent variable.
+/- means the impact depends on the dependent variable.