Distributing Water or Rents? Examples from a Public Irrigation System in Pakistan*

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ABSTRACT

During the last decade, a large number of developing countries have engaged into irrigation policy reforms. Such reforms are frequently associated with changes in the distribution of irrigation benefits among interest groups. This paper investigates the nature of the existing economic rent in public irrigation systems. It proposes a conceptual framework to analyze its distribution between private and public actors involved in irrigation management. A case study is conducted in Pakistan’s Indus basin to quantify the overall level of rent granted to the irrigation sector and to show how farmers compete for the appropriation of the greatest possible share of this rent.

Au cours de la dernière décennie, un grand nombre de pays en développement se sont engagés dans une réforme de leur politique de gestion des périmètres irrigués. Les intérêts économiques de nombreux acteurs sont affectés par ces réformes. Cet article étudie la nature de la rente existant dans les périmètres irrigués publics. Il propose un cadre conceptuel pour analyser la distribution de cette rente entre les acteurs du secteur privé et public. Une étude de cas est réalisée dans le bassin de l’Indus au Pakistan pour quantifier le niveau global de rente accordé au secteur irrigué et pour montrer comment les agriculteurs entrent en compétition pour l’appropriation de la plus grande part possible de cette rente.

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INTRODUCTION

During the last decade, drastic changes in irrigation policies have been proposed and implemented in many developed and developing countries. The main emphasis of these changes is a shift from purely supply-based to more demand-based interventions, and modifications of the institutional framework of the irrigation sector (FAO, 1994; World Bank, 1993). Increasing water scarcity and competition between users over water resources are the most common arguments used to justify such policy changes. However, policy reforms in the irrigation sector also result from the need to reduce government budgetary deficits in the context of structural adjustment programs, and to reallocate scarce financial resources to other more strategic sectors of the economy.

In practice, a large number of these institutional reforms have led to a modification of the respective roles and responsibilities of the state and water users in the management of public irrigation systems. They often imply a significant reduction of public subsidies and an increase in irrigation fees charged to farmers. Also, they are associated with changes in the allocation of water resources between groups of users and may have a significant impact on the distribution of farmers' income.

The observed or estimated impact of such policy changes are often analyzed and discussed in aggregated economic terms, or with regards to the physical sustainability of irrigated agriculture. The consequences of such policy reforms on the distribution of the economic surplus between the various groups affected by the reform are less well documented, although it is widely acknowledged that the success of reform implementation often depends on the vested interests threatened by the proposed changes (Grindle and Thomas, 1991). As institutional reforms are associated with changes in the distribution of irrigation benefits, they inevitably generate resistance and opposition to the proposed changes from various interest groups (Dinar et al., 1998). To anticipate the resistance that may arise during the reform implementation, there is a need to investigate the nature and the intensity of the rents which exist in irrigation systems and which could possibly be threatened by the proposed institutional changes.

This paper investigates three selected issues related to the appropriation of economic rent in large gravity irrigation systems: the nature of the rent and its economic value, the distribution of this rent between stakeholders and the mechanisms of the rent market. These issues are illustrated using examples from irrigation systems in Pakistan, a field site often cited as a major example of rent-seeking behavior. Following a theoretical analysis of the rent and its appropriation by the actors, the paper concentrates on rent-seeking behaviors...
that modify the allocation of irrigation water. An attempt is made to quantify
the individual share of the rent appropriated by actors in a selected irrigation
system. The role, logic and decision-making of the different actors involved in
this rent-seeking process are described; the paper emphasizes that the overall
functioning of large scale public irrigation systems, which has been described
as anarchic\(^1\) by several authors, results from rational behavior and strategic
decisions. The paper concludes by discussing the results obtained within the
larger context of irrigation policy reforms.

I. EXISTING RENT IN IRRIGATION SYSTEMS

A. THE IRRIGATION SECTOR RENT: INVESTMENT SUBSIDIES AND
UNDER-PRICING OF IRRIGATION WATER

In most cases, investments in large-scale irrigation schemes are financed, par-
tially or totally, by public funds. The systematic intervention of the State in the
development of water resources and irrigation infrastructure reveals the
strategic role played by irrigated agriculture in the agrarian development
policy. In Pakistan, as in many other developing countries, public irrigation
has been used to achieve food self sufficiency, to produce cheap raw material
for the domestic food processing and textile industries and to provide job
opportunities to the rural population and avoid massive migrations towards
urban areas. However, a major consequence of these investment subsidies is
that they have favored the development of irrigation projects beyond the
optimal scale: the marginal cost of water in such public irrigation schemes
exceeds its marginal value in agricultural use. Moreover, due to political
considerations\(^2\), the price of water is subsidized and is set, in most cases, below the
marginal value of water (Gardner, 1983; Repetto, 1986).

In figure 1, the downward-slopping aggregate demand curve depicts the
decreasing marginal value of water in agricultural use. The water supply curve
is pictured by the upward sloping curve, which reflects that the cost of mobilizing

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\(^1\) For a description of ‘anarchy’ in canal irrigation systems, see for instance Hart (1978),

\(^2\) Subsidizing irrigation water (as other inputs such as fertilisers or pesticides) reduces the
variable production costs for farmers and leads to a reduction of staple food price for urban
consumers. Many governments have implemented this type of popular measures in order to
gain the political support from the poor urban classes (or at least to avoid political unrest in the
cities). In addition to that, irrigation water and other inputs have sometimes been intensively
subsidized to compensate for the implicit taxation imposed through price control policies,
which have kept the agricultural prices below the world market level. This has been the case in
Pakistan for more than three decades (Rinaudo, 2000).
new resources is increasing. The situation described above is depicted by point M: the public irrigation agency has financed the water storage and conveyance infrastructure to deliver the quantity $Q_{capacity}$ of water, regardless of the marginal value of water in agriculture; at point M, the marginal cost of water is $P_{capacity}$ and the price of water is maintained by the public irrigation agency at a subsidized level $P_s$. With such an administered allocation system, the public agency sets both the quantity of irrigation water and its price.

If water resources had been supplied by the private sector, the equilibrium would have been reached at point E at the intersection of the marginal cost of supply and of the marginal value of water use. The total quantity of water used would be equal to $Q^*$ and the equilibrium price $P^*$. Public intervention in water resource development has thus generated excess profits for the irrigation sector. These excess profits that could not have been obtained in a competitive market are a rent for the irrigated agriculture sector (Ostrom, 1992, p. 33). This rent is equivalent to an excess of economic surplus (for the water consumer) and is shown in figure 1 by the area $[P_s \text{MNEP}^*]$. Underpricing and limited water supply (at $Q_{capacity}$) generate an excess demand for water demand equal to $Q_d - Q_{capacity}$. 

Figure 1. Water pricing distortion and sector rent
B. QUANTIFICATION OF THE RENT IN THE INDUS BASIN IRRIGATION SYSTEM

Using the example of the Indus Basin Irrigation System in Pakistan, the overall rent granted to the irrigation sector can be quantified following the theoretical approach presented above. However, it is necessary to incorporate in the analysis three specific characteristics of the Indus Basin irrigation system (see figure 2):

(i) Canal water supply is not flexible and is entirely determined by the supply capacity of the existing irrigation scheme. The earth-made canals that divert water from the rivers and convey it to farmers have to be run at their design discharge all year round to limit their deterioration. An increase of discharge would lead to a rapid erosion of the bed of the canals whereas a reduction of the discharge below its design level would lead to important deposition of sediments in the canals.

(ii) As in many supply-based irrigation systems, water charges are area-based. Thus, water charges are comparable to land taxes, whatever the quantity of water effectively used and it is equivalent for water users to a fixed production cost.

(iii) The large aquifer underlying the Indus plain provides additional water to farmers equipped with tube-wells, who can use it or sell it to neighbors. Therefore, farmers have the opportunity to use groundwater to supplement canal water deliveries in order to match crop water requirements. In the Indus Basin, the price of traded tube-well water was found to be approximately equal to its marginal extraction cost $P_{TW}$ (Strosser, 1997). Also, it is assumed that the extraction cost is constant and does not depend on the total quantity of water withdrawn from the aquifer.

Under the assumption that all farmers have access to groundwater and that groundwater and canal water are perfectly substitutable, the aggregate water supply curve is shown by the bold line in figure 2. At equilibrium point $E$, the

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3. An increase of discharge would lead to a rapid erosion of the bed of the canals whereas a reduction of the discharge below its design level would lead to important deposition of sediments in the canals.

4. We assume that the amount of water withdrawn by farmers is negligible when compared to the recharge of the aquifer. Consequently, the intensity of groundwater extraction has no impact on the water table level and the marginal extraction cost remains constant (see figure 2). However, this assumption is only valid in a certain range, as an excessive groundwater use in a specific area could lead to a localised depletion of the resource and a raise of its extraction cost.

5. Groundwater is often characterised by higher salt content than surface water. This difference in chemical property of the two sources of water leads to differences in the crop yields obtained. Therefore, the two sources of water are not entirely substitutable.
irrigated agricultural sector will demand a quantity $Q_{\text{capacity}} + Q_{\text{TW}}$, with $Q_{\text{capacity}}$ supplied by the canal system at fixed water charges and $Q_{\text{TW}}$ supplied by tube-wells at volumetric price $P_{\text{TW}}$. The rent generated by canal water under-pricing is equal to the difference between the opportunity cost of water at $Q_{\text{capacity}}$ and what the system charges for its use, i.e. the fixed water charges. This rent is represented by area (A) shaded in light gray (in figure 2) minus the total fixed water charges (S).

As illustrated in figure 2, the value of the rent granted to each irrigation scheme varies with: (i) the total canal water supply $Q_{\text{capacity}}$ and (ii) the availability of groundwater. The official canal water allocation to each irrigation scheme varies within the Indus basin. In the Punjab Province for instance, the allocation at the head of the main canals ranges from 3,100 to 14,000 m$^3$ per hectare and per season, with an average of 6,850 m$^3$/ha/season. The quality and accessibility of groundwater are also highly variable: in certain areas of South Punjab and in most of the Sindh Province, farmers cannot irrigate with groundwater because the aquifer is too saline and would cause soil fertility degradation. In such case, the public canal system remains the only source of irrigation water and the shadow price of water is at $P^*$ (figure 2), above the average price of tube-well water in other areas. The global rent generated by the under-pricing of canal water is then equal to area $(A+A')-(S)$, and is therefore higher than in areas where other sources of irrigation water are available.
A case study was conducted in a specific canal irrigation system located in South-East Punjab to quantify the value of the rent defined above. The calculation was done on a per hectare basis. The average canal water supply and the water charges were collected from the divisional office of the Provincial Irrigation and Power Department (PIPD). An estimate of the average price of tube-well water (0.4 rupees per cubic meter) was computed based on information collected through a survey of 278 farms by Strosser (1997). We then calculated the average value of the rent (area A) which amounts approximately to rupees 2,000 (US$60) per season and per hectare of land entitled to irrigation. The comparison of the value of the rent with the average gross margin for cotton and wheat cultivation which are respectively equal to $285 and $130 (estimates based on the same 278 farms sample) demonstrates that the irrigation rent represents a large share of farmer revenue. As explained above, the value of the rent is expected to be even higher in areas where farmers do not have access to groundwater.

II. APPORTIONMENT OF THE RENT BETWEEN ACTORS OF THE IRRIGATION SECTOR

Each unit of subsidized water carries a share of the sector rent defined above. The share of the total rent that can be appropriated by each water user is directly related to the quantity of water he/she receives. In most large-scale gravity irrigation systems, the quantity of water allocated to each farmer is directly proportional to the land he/she owns in the canal command area. Each farmer is entitled to a given quota of water and which is, in most cases, inferior to her/his demand. The opportunity to enjoy a greater share of the rent by using more water generates incentives for farmers to find ways of increasing their access to this rent-generating resource (Ostrom, 1992, p. 33).

In Pakistan's irrigation systems, farmers have two options to increase their individual share of the rent. The first option consists of occasionally stealing water from a neighbor or from the main canal system, bearing the risk of penalty. The second option consists of investing in activities which aim at influencing the officials in charge of the allocation procedures in order to obtain an increased (and more permanent) water allocation. Such activities, which do not produce goods or services but which yield the appropriation of a greater share of the rent, are called rent-seeking activities (Krueger, 1974; Ostrom, 1992). They involve transaction costs with the officials (time, transportation, bribes, organization of collective political action). As noted by

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6. Thus, the apportionment of the rent due to under-pricing of water reflects the inequality of the land allocation.
Bhagwati (1982), the financial resources invested by farmers to cover these costs are not directly productive but sunk costs. Rent-seeking activities fundamentally differ from theft because they imply that a 'political market' takes place between farmers and officials leading to an agreement. This agreement which determines the actual allocation of water is not necessarily officially acknowledged (it frequently involves corruption), but it is usually known and accepted by the different parties at stake. Using Ostrom's terminology, this informal allocation mechanism is part of the working rules (Ostrom, 1992, p. 20). Theft, on the contrary, does not rely on any agreement but on an estimation by farmer of the penalty and the probability of being caught. In the following part of this paper, we will specifically focus on the rent-seeking strategy.

Figure 3 depicts the additional share of the rent captured by a farmer who would negotiate with the irrigation agency staff to obtain an increase of his/her water allocation. It shows the individual water supply curve of the farmer who (i) gets an official canal water quota $Q_c$, (ii) has access to tube-well water at a constant price $P_{TW}$, and (iii) has the possibility to appropriate extra water through rent-seeking activities at increasing marginal cost (shown by the upward-sloping curve) resulting from negotiations with PIPD staff. Under these conditions, the farmer will supplement his/her canal water quota with a quantity $QRS$ obtained though rent-seeking activities. Beyond point C, the marginal cost of rent-seeking exceeds the marginal cost of tube-well water $PTW$. It is then more profitable to buy additional quantities of groundwater $QTW$. The aggregate water consumption of the farmer will then be equal to $QC + QRS + QTW$.

Overall, the individual share of the rent appropriated by the farmer depicted in figure 3 is the area (A) plus the area (B), minus the fixed official water charges (S). The area (A) is the share of the rent that every user should get if water was allocated according to official rules. The area (B) is the extra share of the rent that the rent-seeker obtains after negotiation with the irrigation agency staff. Under the assumption that the costs of individual rent-seeking are mostly due to corruption, the area (C) represents the bribes appropriated by the irrigation agency. It is interesting to note that this amount (C) is not reinvested in the agricultural sector but transferred to other sectors of the economy and possibly outside the country.

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7. Note that in situations when the price of tube-well water is below the curve of marginal rent-seeking costs, the farmers will avoid rent-seeking activities and will prefer to use tube-well water, whether from own their tube-well operation or purchased from neighbouring tube-well owners.
Figure 3. Cost of rent-seeking, tube-well water price and individual rent

Figure 3 also shows that the size of the individual share of the rent obtained by each farmer depends on: the individual water demand; the canal water entitlement (official quota); the tube-well water price; the marginal cost of rent-seeking. In farming systems characterized by a high heterogeneity in the access to financial and water resources, these four factors may vary significantly among areas and water users. Therefore, farmers do not face the same rent-seeking incentive. In areas with no access to groundwater resources such as the Sindh Province, the area (B) and the potential benefits from rent-seeking activities are likely to be more significant. Field observations in several sites tend to support this statement: farmers’ involvement in rent-seeking activities is higher in the Sindh Province as compared to the Punjab Province.

If the terms rents and rent-seeking are so often misunderstood by non-economists, and even by some economists (Ostrom, 1992, p. 33), it is probably because it refers to different phenomena. As explained above, farm lobbies may engage into rent-seeking activities to attract and secure subsidies in the irrigation sector. Individual farmers may also engage in a different type of rent-seeking activities which aim at increasing or securing their individual share of the sector rent. And, officials from the irrigation agency in charge of

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8. A study conducted by the International Irrigation Management Institute (IIMI) in three distributaries located in the Shangar, the Nawabshah and the Mirpur Khas sub-divisions (Sindh), highlights that respectively 30%, 88%, and 63% of the outlets were tampered (Lashari et al., 1997). However, differences in rent-seeking behaviour between the field sites of the Punjab and Sindh Provinces cannot be solely explained by differences in the access to groundwater resources, and other socio-economic factors are expected to play a role.
allocating water may try to appropriate a share of the rent through extortion and corruption.

The term rent is often associated with a negative connotation, rents being perceived as illegitimate transfers. However, it is important to point out that the sector rent due to under-pricing of irrigation water is the outcome of political decisions involving policy makers and pressure groups from the society: this rent is thus legitimate. The apportionment of the rent between actors does not benefit from the same legitimacy, since it is not based on the law but on informal institutions. However, as stressed above, the apportionment of the total rent between individual is based on working rules, which though informal, are widely accepted by the different actors involved in water management. It thus contributes to grant them with some legitimacy.

The theoretical elements presented above are illustrated in the following section by results obtained in a case study conducted in an irrigation scheme of the Pakistani Punjab.

III. WATER ALLOCATION AND INDIVIDUAL RENTS IN PAKISTAN IRRIGATION SYSTEMS

A. WATER CONTROL STRATEGIES

Like most irrigation systems in the Indian sub-continent, the Indus Basin Irrigation System was designed to spread a limited quantity of water on an area as large as possible in order to prevent crop failure and eliminate recurrent famines (Jurriens and Mollinga, 1996). The scarcity is shared out between potential users through the implementation of a quota system. From the 1960s onwards, the mounting population pressure and the water intensive techniques promoted by the Green Revolution increased the demand for irrigation water.

Farmers have developed several strategies to increase their control over water resources. Firstly, better-off farmers, strongly encouraged by public subsidy programs, have invested in private tube-wells to tap groundwater resources: it helped them increase total water resources available at the farm and compensate for the variability and unreliability of canal water supply. Overall, more than 400,000 private tube-wells have been installed in the Indus plain during the last 20 years, mostly in the Punjab Province which is underlain with good quality groundwater. Secondly, farmers participate in water markets. Intensive tube-well water markets have developed within a large range of physical and socio-economic environments (Strosser and Meinzen-Dick, 1994). Small farmers who do not have the financial capacity to invest in a tube-well gain access to groundwater resources by purchasing it.
Local surface water markets are also very common within watercourse command areas (Rinaudo et al., 1997a; Strosser, 1997). Thirdly, farmers try to steal water or to influence the irrigation agency staff in order to increase their own allocation of surface water. Such interference of users in the allocation process typically leads to the appropriation of extra canal water by farmers favorably located in the irrigation system at the expense of other water users.9

These three strategies can be observed in Punjab irrigation schemes where groundwater is generally suitable for irrigation. The socio-economic variables explaining the choice of one of these strategies will not be investigated in the present paper. In the following sections, we will focus exclusively on the third strategy.

B. WATER ALLOCATION IN PAKISTAN: FROM THEORY TO PRACTICE

A typical canal command area of the Indus Basin Irrigation System is a ramified system which consists of: (i) a main canal that diverts water from the Indus River or one of its four tributaries; (ii) a number of gated structures along the main canal to supply water to secondary canals or distributaries; (iii) non-gated structures or outlets spread along the distributary to supply water to tertiary channels or watercourses (see figure 4). Below the outlet, farmers share canal water following a weekly roster of water turns or warabandi, with one farmer at a time using the water flow supplied to the watercourse.

In theory, water allocation is based on the principle of equity: the same quantity of water is allocated to each hectare of cultivable land. Each hydraulic unit is entitled to an authorized discharge proportional to its command area. At the main canal level, the irrigation agency staff operates the gated structures to regulate the flows in the main canal and to supply each distributary with its authorized discharge. Along the distributaries, the apportionment of water between watercourses is determined by the dimensions of the outlets. Below the outlet, the equity principle is incorporated in the warabandi schedule, the duration of the water turn of each individual user being proportional to the size of her/his land holding.

Research studies have emphasized that existing water allocation is not equitable. Water turns are not allocated equitably between water users of a given watercourse (Bandaragoda and Rehman, 1995). Average discharges received by distributaries and watercourses are at variance from their official figures. Flows are no longer shared equally between the different hydraulic units with the tail areas generally bearing the bulk of water shortages (Bhutta and Vander Velde, 1992; Kuper, 1997).

9. Such interference represent rent-seeking activities as defined in section three.
Several technical factors have been advocated to explain the observed pattern of water distribution. Those include an inadequate and variable inflow at the head of the main canal, a localized operation of gate keepers, important deposit of sediment which modifies the geometry of the channel and the absence of adequate information for the management of the irrigation system (Kuper, 1997). However, inequity in water distribution is also due to the interference of water users in the management of irrigation systems: farmers frequently try to influence the decisions of the PIPD staff. This has a significant impact on actual pattern of water allocation. Although such interference is increasingly reported not only in the media in Pakistan, but also by officials from the irrigation bureaucracy (Ullah, 1994), by donors (World Bank, 1994) and by policy makers (Government of Pakistan, 1993), the nature of the interaction between the PIPD staff and farmers has not been well documented so far.

The analysis of water users’ strategies presented below relies on intensive fieldwork conducted in one irrigation sub-system located in Pakistan’s Punjab and supplying water to approximately 70,000 ha. Given the sensitivity of the issue at stake, the material needed for the analysis could not be collected with the standard sampling and interview methods. The authors have relied on
more informal means to obtain the information on which the paper is based. Qualitative information obtained through interviews has been cross-checked with physical measurements of infrastructure or discharges in the canals whenever this was possible. The quantitative analysis of water allocation in one sample secondary canal presented in the last part of this section relies on primary data: the geometry of the canal, the dimensions of the outlets and the discharges at the head of the canal were actually measured and used to conduct the hydraulic analysis presented below.

C. HOW DO FARMERS INTERFERE IN WATER ALLOCATION?

To increase his/her individual water allocation, a farmer can try to modify one of the three following variables: (i) the duration of his/her water turn, (ii) the discharge of the watercourse which brings water to his/her fields, or (iii) the discharge at the head of the secondary canal which supplies water to his/her watercourse.

(i) Within the framework of fixed rotations of water turns (*pakka wara-band*), which are established and enforced (in case of conflict) by the PIPD, an increase of the duration of a water turn can only be obtained at the expense of other water users located along the same watercourse. Since the number of farmers within a watercourse command area is generally small (around 20-50 farmers), and because of the social links existing between water users belonging to the same community, such events remain extremely rare.

(ii) To avoid conflicts which could threaten the social cohesion of the community or village, farmers generally prefer to obtain from the PIPD staff an enlarged outlet, which results in a permanent increase in the design discharge (or allocation) of the watercourse. Less frequently, it happens that farmers obtain a second outlet\textsuperscript{10}. The extra water allocation benefits all farmers of the watercourse, and is done at the expenses of other water users located several kilometers downstream along the distributary. These farmers rarely belong to the same village or community, which minimizes the risk of conflict.

(iii) Obtaining a permanent increase in the discharge at the head of the distributary is the third possible intervention to get a higher water allocation. This increase represents a *de facto* change in the surface water allocation to the distributary. It benefits all the outlets located along the distributary.

\textsuperscript{10} When the land of a watercourse is severely affected by salinity, a provision of the Canal and Drainage Act offers to PIPD officials the possibility to install a temporary pipe outlet. The total quantity of water supplied to the watercourse is thus increased during a period (maximum three seasons) in order to leach the salts in the soil. Field observations, however, have shown that these pipes are rarely removed at the end of that period.
Direct interventions by farmers at the three levels are also frequently reported; such interventions, which occur during a short period of time, can be assimilated to theft because they do not result from a negotiation process but from a unilateral decision. Examples are the use of flexible siphoning pipes from the distributary to neighboring cultivated areas, cuts in the banks of the distributary, deterioration of gates or weirs or direct maneuvering of the gates. Such interventions occur mostly at night, during periods with high flow variability and water stress, and last for a few hours only. It is interesting to note that if farmer’s action is detected by the PIPD staff, he/she will probably engage \textit{a posteriori} into a negotiation in order to reduce the amount of the fine to be paid. This example shows that there is a continuum between rent-seeking activities and theft, involving officials from different ranks.

D. ARE INDIVIDUAL RENTS QUANTITATIVELY IMPORTANT?

Using the example of the modification of the outlet dimensions (or outlet tampering), an attempt is made to quantify the impact of water users’ interference on water supply and to assess the consequences in terms of rent appropriation. A large secondary canal of the Indus basin irrigation system with a command area of 16,000 hectares and supplying water to 80 watercourses units, has been selected to conduct a detailed case study.  

The methodology developed makes use of a hydraulic simulation model, SIC (Malaterre et Baume, 1997), which has been calibrated and validated for the sample distributary. Using the actual geometry and the discharge at the head of the secondary canal as input for the model, as well as the dimensions of all the outlets, the model computes the discharge flowing through each outlet. Two situations are compared to estimate the marginal impact of outlet modification on watercourse head discharges: (i) the actual water distribution as observed in a base year (1994), and (ii) the simulated distribution corresponding to the scenario where all tampered (modified) outlets are brought back to their original dimensions. Figure 5 presents the results of the comparison between the two situations, with the estimates of the volumes of

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11. Because of the number of factors that influence the discharge to tertiary units, a simple comparison between actual and official discharges is not sufficient to quantify the impact of outlet tampering on volumes supplied to tertiary units. In fact, a variation in the discharge received by a specific watercourse can result from outlet modification, but also from technical factors such as sediment deposition or erosion of the bed of the secondary canal, or from the fact that upstream watercourses appropriate more water than their due share.

12. The actual and the simulated patterns of water distributions are estimated taking the same inflow at the head of the sample distributary and the same geometry of the channel (for technical details on these methodological aspects, see Rinaudo and al., 1997b).
water in excess of the official allocation, obtained through outlet change (bars in black), and the related volume losses for downstream outlets (bars in gray).\textsuperscript{13}

Outlets located downstream of the over-sized outlets show a consistent reduction in discharges. However, this negative impact is diffused between all the watercourses and remains significantly less important in terms of individual volumes lost than the extra volumes gained by individual over-sized outlets. Also, the rent-seekers are in a position to quantify directly the impact of their interventions (at least in the short term). On the contrary, the deprived water users (tail section of the canal) do not have enough information on the physical characteristics and water withdrawal of each upstream outlet and are therefore not able to identify where and by whom the missing water has been diverted.

Several assumptions are made to transform these volumes into financial values. Its is assumed that the extra volumes of canal water received allow farmers to reduce their water constraint and limit groundwater use for 11 months per year (the canal system is closed in January for yearly maintenance activities). By multiplying the monthly volume reported in figure 5 by 11 month and by an average tube-well water price of US$ 0.01 per m\textsuperscript{3}, the value of the additional income permitted by the outlet modification is roughly

\textsuperscript{13} The sum of the positive and negative deviations weighted by the area of each watercourse is equal to zero.
Table 1. Variations of the individual share of the rent along the sample distributary

<table>
<thead>
<tr>
<th>Gainers: 9 outlets</th>
<th>Extra surface water (m³/ha/month)</th>
<th>Changes in income (US$/ha/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>445</td>
<td>55</td>
</tr>
<tr>
<td>Minimum</td>
<td>110</td>
<td>14</td>
</tr>
<tr>
<td>Maximum</td>
<td>1930</td>
<td>243</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Losers: 40 outlets</th>
<th>Average</th>
<th>Changes in income (US$/ha/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>-15</td>
<td>2</td>
</tr>
<tr>
<td>Maximum</td>
<td>-180</td>
<td>23</td>
</tr>
</tbody>
</table>

estimated and presented in Table 1 for the sample distributary. The comparison of this value with the price of the rent of land (US$350 per ha and per year) or with the average gross margins for major crops ($285/ha and $130/ha for cotton and wheat) reveals the financial significance of the individual income changes due to outlet modification.

Accurate information related to the cost of individual rent-activities was more difficult to obtain. Based on informal discussions with farmers and low ranking irrigation officials, the level of bribes (i.e. the direct financial transfers) paid by farmers to the irrigation department officials was estimated between $140 and $430 per outlet and per year. On a per hectare basis, the bribes approximately amount to $1.40/ha, which only represents 2.5 per cent of the average rent (per hectare) appropriated by the rent-seekers in our sample canal. Overall, actual costs of rent-seeking activities will be higher than these estimates which do not take into account other organizational and transaction costs (in terms of time spent, for example) incurred during the negotiation process with irrigation department officials. All these costs represent a net loss of resources for the agricultural sector. Thus, corruption is detrimental to the productivity of the sector as a whole as it reduces the amount of resources to be invested in production activities.

The assumptions made to estimate the financial value of the rent and induced losses remain rather simplistic. Firstly, the time variability of the

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14. The authors found similar values through interviews conducted in other areas of South Punjab (Haroonabad division) and Sindh (Sanghar, Mirpur Khas and Nawabshah divisions). Similar values are also reported by IIMI (Lashari and al., 1997).

15. These figures highlight the significance of the funds siphoned out of the irrigated agriculture sector. To illustrate, we take the example of the Chishtian administrative sub-division, which consists of 522 outlets, 40 per cent of which are tampered (Kuper, 1997). Under the assumption that only half of the farmers who tamper outlets pay a bribe (others use their political connections), and taking a low estimate of the bribe ($140 per outlet), the funds diverted into private pockets could approximately amount to $14,600.
observed phenomenon has been neglected. Extra volumes obtained through outlet modification or lost by downstream users will vary over time due to the variability of the distributary head discharges. Also, the marginal value of canal water is not always equal to tube-well water prices and is expected to vary over time (Strosser, 1997). Secondly, the spatial heterogeneity of some factors has been neglected. With the assumption of equal average tube-well water price for all watercourses, the reallocation of surface water through illegal tampering does not modify the aggregate financial output of the sample distributary command area. However, field conditions have shown that large differences exist between watercourses in terms of tube-well water prices, and also in terms of the potential access to groundwater resources.

E. SUMMARY AND ISSUES

The financial values of the extra volumes of canal water allocated to some or lost by others have been only roughly estimated. To refine these values, however, would require significantly more detailed information on both the temporal and spatial variability of the main variables investigated.

Overall, the type of intervention selected by an individual water user to improve irrigation water supply (i.e. tube-well installation, water markets, various types of interference) will depend on a large number of factors such as access to surface water and groundwater resources, the location within the hydraulic unit, the economic and the political power of the individual user or of user groups.

This analysis, undertaken using the information on outlet sizes collected during the 1994 season, hides the dynamic dimension of the phenomenon under study. Five years of field activities in the command area of our sample distributary and surroundings canal systems have shown that outlet dimensions are regularly modified, brought back to design dimensions and tampered again. Thus, the rents that accrue from changes in outlet dimensions are expected to vary over time. This dynamic dimension of the rent-seeking system stresses the need to investigate actors and their strategies to better understand this phenomenon.

IV. DYNAMICS OF THE RENT MARKET

This section defines the basis of a framework analyzing how rents are shared between private and public actors involved in water allocation. This framework is based on detailed field observations, informal discussions and interviews conducted with farmers and PIPD officials.
A. ACTORS OF THE RENT MARKET

In section 3, we have highlighted that farmers favorably located in the upper reaches of the system are likely to obtain an increased water allocation through negotiation with the PIPD staff. Because of the key role they play in the monitoring of the infrastructure and discharges in the system, the resolution of conflicts over water distribution and the enforcement of law and order, the staff of the PIPD are favorably situated to extract through extortion and corruption part of the individual rents they distribute to farmers (Moore, 1989; Ostrom, 1992; Repetto, 1986). Water is exchanged against bribes on a virtual place of interaction which we will call a water rent market\textsuperscript{16}.

However, administrative corruption is not the only mechanism through which farmers can appropriate rents. Political influence can be substituted to bribes to gain control over the PIPD staff. Influential farmers who are well connected to high-level administration officers or to local politicians (for example, members of the Provincial or National Assemblies) are able to put pressure on the local staff of the irrigation bureaucracy in charge of water distribution. By using their influence to obtain increased water supply to their constituencies, politicians gain political support and secure their position in office. As a reward for delivering water as required (in place and quantity) by politicians, co-operative local staff of the PIPD benefit from promotions and favourable posting\textsuperscript{17}.

In summary, three types of exchanges or transactions take place (see figure 6). Irrigation agency officials and farmers trade water against financial transfers on the water rent market. Farmers and politicians are linked through a political clientelist network where they trade votes against political power and pressure. Irrigation agency staff and politicians are connected through an administrative clientelism network where promotions and careers are traded for favorable administrative decisions.

As total water resources are limited, farmers compete among each other to obtain the largest possible share of the rent. The allocation of water (and thus the apportionment of the rent) is not determined by the relative economic efficiency of the potential recipients, but by their relative ability (in terms of political pressure and financial incentives) to gain control over government officials who allocate water.

\textsuperscript{16} In most of the specific cases encountered through interviews and discussions, the rent market is not a virtual place but can be localised in the office of the sub-divisional officer where farmers physically come to negotiate their water supply.

\textsuperscript{17} Wade (1982) and, more recently, Mollinga (1998) report on the existence of similar interference of local politicians in the functioning of south Indian irrigation systems.
Field investigations have highlighted that despite the high heterogeneity in the socio-economic characteristics of water users, most of the water users located favorably along the hydraulic network participate in the rent market. Small farmers form a coalition in order to mobilize political support collectively and to overcome their individual financial constraints. They frequently nominate a representative member (called the ali) who negotiates with the PIPD officials the amount to be paid and collects this amount from farmers. The amount of financial resources invested in rent-seeking activities and the political support at stake will determine the level of negotiation: for example, low-ranking officials such as gate keepers offer limited increase of distributary head discharges against bribes\textsuperscript{18} while higher-ranking officials are involved in negotiations resulting into permanent outlet modification, the setting-up of new and permanent outlets or long term changes in the allocation to secondary canals.

Rent market transactions also generate negative (and positive) externalities, identified as negative (and positive) variations of water supply for those who do not participate in the transaction. For instance, a farmer located on a watercourse where a group of farmer negotiate for the modification of the outlet automatically benefit from the increased discharge, even though he/she does not participate in the transaction. Similarly, farmers located on downstream watercourses along the distributary suffer from a reduction of their

\textsuperscript{18} At low administrative levels, bribes are not paid in cash but in kind (cereals, cattle, etc.).
water supply. In the case of short-term interference (theft of water with the use of siphoning pipes during the night), negative externalities are transitory and deprived farmers are rarely able to identify the origins of a reduction in their water supply. On the other hand, long-term modification of the allocation may induce durable and more transparent negative externalities, and trigger potential counter-action from losing groups.

B. DIVERSITY OF RENT-SEEKING STRATEGIES

Field observations have revealed the diversity of rent-seeking strategies in terms of (i) the level of intervention along the hydraulic network, (ii) the choice between individual and collective interference, and (iii) the expected duration of the impact of the interference (short term versus long term). To understand the diversity of strategies observed, it is assumed that all the actors involved in the rent market (farmers, politicians, agency staff) seek to maximize their utility under constraints. Farmers’ utility is measured by their expected net benefit function (value of the rent minus the costs of rent-seeking activities). Politicians seek to be re-elected and therefore try to maximize political support. Agency staff maximizes the net revenue gained by distributing rents (the revenue includes the financial compensations paid by farmers and promotion obtained through political support).

Farmers’ decisions to engage into rent-seeking activities are also linked to the constraints they have to face. When the main constraint is the total availability of water, farmers will seek to increase their expected water supply over a whole cultivation period in order to intensify agricultural production. In such cases, negotiations between farmers and line agency staff take place at the beginning of the planting season, are rather lengthy and involve higher-ranking officials. The outcome of these negotiations determines how outlets will be tampered, whether permanent reclamation pipes will be installed, and what will be the level of distortion obtained in target discharges at the head of the distributaries. When the constraint is uncertainty and variability of surface water supply, farmers’ (emergency) objective is to alleviate the effect of transitory water shortages on yields. In such cases, farmers can not engage into a long negotiation process and prefer to take direct action: they install flexible pipes, make cuts in the bank of the distributary, or maneuver the gates at night to increase the head discharge for a few hours only. The impact of such actions is only temporary, related transaction costs are minimized but the risks are high.

Farmer’s individual ability to influence the line agency staff may also be a major constraint guiding the choice of a specific rent-seeking strategy. Collective interference is often a response to a low individual capacity to negotiate with authorities, either because of financial constraints or because of a
lack of political connection. Forming a coalition is then the only effective solution to compete with other more powerful rent-seekers. It is an effective strategy when organizational costs (including the costs of free-riding control) remain limited. Also, there is an incentive for collective action when the benefits of interference activities cannot be individualized. This is mostly the case for outlet tampering activities. On the contrary, an individual strategy is chosen by farmers who have a high personal bargaining power with the authorities, either a high capacity to pay and/or political connections.

Whether the benefits of the interference can be individually or collectively appropriated is also a key factor determining the choice of a rent-seeking strategy. In theory, it is assumed that the rent-seeker will be prepared to pay for the totality of rent-seeking costs as long as his/her net individual benefit remains positive, and even if it produces collective gains. However, the rent-seeker may seek to internalize part of the positive externalities. An individual farmer obtaining an enlargement of an outlet, for example, can negotiate a longer water turn with other farmers of the watercourse command area to capture a greater share of the benefits of his/her rent-seeking activity. However, the internalization of positive externalities is possible only if the costs of internalization remain limited.

In summary, the strategic choices of water users when engaging into the rent market depend on the net benefit expected from the intervention and their ability to overcome the major constraints. Field observations suggest that this ability is determined by the social and economic characteristics of each farmer and also by the organizational capacity of the local community, itself determined by its social homogeneity, its influence in the local political arena and the existence of instruments of free-riding control.

C. DYNAMICS OF THE RENT-MARKET: A HISTORICAL PERSPECTIVE

Interviews conducted in our study area have highlighted the dynamic nature of the rent market. The changes in outlet dimensions are made by the line agency staff on a temporary basis, and they are periodically re-negotiated. Similarly, changes in distributary head discharges are not permanent, and are regularly the object of negotiations between the irrigation agency staff and individuals or groups of farmers. It seems to indicate that the irrigation agency staff regulates the competition between rent-seekers, and maintains the potential costs of tail-enders’ opposition under a threshold guaranteeing the stability of their position. Under a situation of asymmetric information, the most efficient strategy for the irrigation agency staff is to reduce the durability of the privileges granted to specific groups by imposing frequent renegotiations to force farmers to move towards short-term rent-seeking.
It seems that there is also a long-term dynamic of the rent market. Since the inception of irrigation systems in Pakistan, there has been significant changes in rent-seeking strategies, apparently explained by the progressive increase of water scarcity in irrigation systems. During the initial stages of development, cropping intensities were low and the pressure over surface water resources limited. Thus, the level of interference remained minimal. As the population and its demand for food product increased, the pressure over water resources was accentuated, leading to a higher level of interference. However, the arena of negotiation over water remained limited to the water-course command area, with powerful farmers taking longer water turns at the expense of smaller farmers.

In the 1960s, the pressure over water resources further increased, both as a result of the population increase and of the Green Revolution. Because irrigated agriculture became more profitable, large land-owners also shifted their activities from extensive livestock production to more intensive irrigated farming. Wealthy farmers installed their own tube-wells to increase their control over water resources. At the same time, at least in the less feudal societies of the Punjab, counter-actions of small and medium size farmers led to the shift from a flexible, negotiated and inequitable system of water turns (kaccha warabandi) to a system of de facto water rights (pakka warabandi). With the recognition of these rights, the possibility to appropriate extra water supply within the watercourse command area significantly decreased. Thus, rent-seekers increasingly focused their interventions at higher levels of the irrigation system, mainly at the distributary level. The tampering of outlets and the direct appropriation with siphoning pipes and cuts in the banks became a common practice. Also, the interference in the management of the main canal to modify the allocation and distribution to distributaries became more frequent.

These changes emphasize the range of adaptive strategies adopted by rent-seekers to respond to exogenous and endogenous constraints. In the 1960s, as water scarcity increased, rent-seekers could not appropriate extra canal water at the expense of their direct neighbors without risking to raise costly social conflicts. They consequently chose strategies with more diffuse negative externalities to minimize the costs of responding to potential counter-actions. Through this strategic choice, rent-seeking farmers successfully obtained water rents, but they had to intervene at higher levels in the irrigation system and forego a larger rent share appropriated by irrigation agency officials. Line agency staff has therefore seen their strategic role in the rent market gradually reinforced. They are now in a dominant position, which they want to maintain.
DISCUSSION AND CONCLUSIONS

This paper stresses several major characteristics of existing rents in the irrigation sector in Pakistan. Firstly, it shows that the value of the rent is fairly high relatively to crop revenue, and that it is not shared equally between farmers. Secondly, it indicates that rent-seeking activities are not confined to wealthy and politically influential farmers: despite potential constraints in terms of financial resource and ability to mobilize political support, small and medium-size farmers also interfere in water distribution, especially when they are located in the upper reach of the hydraulic system. Thirdly, the paper shows that rents are shared between three types of actors: politicians, officials of the irrigation agency and water users through a system of administrative and political corruption. A consequence of this is that a significant share of the rent intended to benefit to farmers is transferred out of the agricultural sector, which is detrimental to the level of investment in the sector and to its productivity.

The identification of new rent-seeking strategies that could emerge as a result of policy reforms represents then an important issue in the context of the analysis of the political acceptability of these reforms. In the case of Pakistan, and similarly to what has been proposed in several other countries, policy makers recommend that farmers take over the operation and maintenance at the secondary canal level to restore equity in water distribution. Water user's federations, composed of a number of water user associations formed at the tertiary unit level, would constitute an arena where water distribution could be negotiated by different groups of farmers. This organization would replace the current system of bilateral negotiations where each group of farmers negotiates individually with PIPD staff but not with other farmers. Coalitions between groups are expected to emerge, especially at the tail end of the distributaries. As a result, a diminution or elimination of the direct appropriation of water from the distributary can be expected. And the new pattern of water distribution would be more likely to be socially accepted by all within the command area of the distributary.

However, farmers who used to appropriate extra water supply through outlet tampering are likely to shift the focus of their rent-seeking activities from the outlet to the regulation gate located at the head of the distributary. The competition for rents that existed between farmers or groups of farmers within the same distributary may disappear and be replaced by a competition between the newly formed water user's federations within the main canal

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19 Using Bardhan's broad definition of corruption as “the use of public office for private gains”, we distinguish here the use of political position from the use of administrative position.
command area. Because of the control they will retain on allocation and distribution at the main system level, line agency staff will still be in an advantageous position to appropriate a share of the rents. The politicians may also continue interfering in the distribution of water as they did in the past, supporting certain federations but not others. And the inequity in water distribution which existed at the distributary level may simply shift to the main canal level.

If corruption reappears at this higher level, the outcome of reform implementation may be fairly different from the expected results. To avoid that corruption provokes a reform failure, it seems important to identify the measures which can help reducing the intensity of this phenomenon. Measures usually recommended such as increasing the level of sanction for corrupt officials or raising the probability of inspection (through the reinforcement of an anti-corruption administration for instance) are not likely to yield significant results in the Pakistani context. In fact, past experiences to eradicate administrative corruption undertaken under the regime of Ayub Khan in the 1960s and Zulfikar Ali Bhutto in the 1970s have shown that even a strong anti-corruption administration could itself succumb to the temptation. In the present case, this type of measure would only add one more player in the rent-sharing game, reducing the rent appropriated by the PIPD staff, and possibly increasing the total amount of resource transferred outside the agricultural sector, but with no impact on the actual intensity of corruption.

An effective strategy to reduce the intensity of rent-seeking behaviors would consist of improving the transparency of the functioning of the hydraulic system, so that the groups deprived from their due share of water realize the origin of their losses and engage into counter-actions in order to defend their water rights. Practically, this means that a reliable information related to the discharges that enter the main canal and each distributary should be collected and shared between all the federations receiving water from the same main canal. This would greatly facilitate the detection of irregularities in the distribution of water. Also, because each federation would comprise one or more large landowners, all the federations would have a similar negotiation power. Consequently, provided there is no asymmetry of information between the federations, equity could be restored, corruption eradicated, and the transfer of the rent outside of the agriculture sector reduced.

20. According to Transparency International which has developed an indicator to measure the level of corruption in a country, Pakistan was ranking 2nd out of 54 classified countries in 1996, and 12th out of 99 classified countries in 1999. This could reveal that corruption is not a specificity of the irrigation sector and highlight that top-down anti-corruption measures are not likely to be very effective.
REFERENCES


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footnote