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I. Introduction

A. Recent literature on "privatization" of resources emphasizes the advantages of private ownership and market exchange over bureaucratic control and allocation:

1. Stroup and Baden (1983) emphasized the rigidities of nontransferable public rights in resources and the inefficiencies of bureaucratic resource management in energy, groundwater, and timber.
2. Rent seeking under government agency programs has been analyzed by
   a. Gardner (1983) and Rucker and Fishback (1983) for water;
   b. Libecap (1978; 1982; 1984; 1986) for minerals, rangelands, and petroleum;
   c. Deacon and Johnson (1985) for forestry.
3. Anderson (1983a, b) has analyzed the transition of western water rights from early (mining) appropriations doctrine to the concept of "beneficial use."

B. The establishment of markets is usually inhibited in the presence of pervasive externalities, such as water pollution or changes in return flows. The sale of water nearly always has positive and/or negative direct

impacts on third parties. Yet, fairly extensive markets have developed for water, and these markets, while sometimes involving rather high transaction costs, appear to have been successful in tranferring water from lower-valued to higher-valued uses over time.

C. It is increasingly important that existing water supplies be allocated more efficiently than in the past because:

1. New water project costs are high:

   a. $200 per acre foot for the Bureau of Reclamation's Animas-LaPlata Project in Colorado and New Mexico (Howe);

   b. $450 per acre foot projected for the State Water Project in California (Wahl, 1985).

2. Climatic changes, such as the CO_2-induced greenhouse effect, may decrease runoff by as much as 76% for the Rio Grande (National Research Council, 1983).

D. This paper will identify characteristics that would be generally desirable for resource allocation mechanisms and argue that, for water, markets often possess more of these characteristics than their alternatives, even within the existing federal and state legal frameworks.

II. Desirable Characteristics of Resource Allocation Mechanisms and Their Implications for Water Markets

A. We are interested in comparing the likely behavior of alternative mechanisms for allocating resources among users at the regional, river basin, or conservancy district level, invoking six criteria derived from theory and experience:

1. Flexibility in the allocation of existing water supplies. Water needs to be shifted from use to use and place to place as climate, demographic, and economic conditions change over time. Both long and short-term flexibility is needed. To be operationally flexible, it is not necessary that all water be subject to reallocation, only that there exist a tradable margin within each major water-using area that is subject to low-cost reallocation.

2. Security of tenure for established users. Only if the water user can be assured of continued use will the user invest in and maintain water-using systems.

3. Confronting the user with the real opportunity cost of the resources available for his use.

4. Predictability of the outcome of the process. Change to a new allocative process, while promising some advantages, may increase uncertainty

about the outcome. Many persons fear water markets because they cannot anticipate how extensive the reallocation (especially from agriculture to cities) might be.

5. A water allocation process should be perceived by the public as equitable or fair. For example, water users should not impose uncompensated costs on other parties.

6. A socially responsible water allocation process must be capable of reflecting public values that may not be adequately considered by individual water users. For example water quality and instream flow maintenance may generate large public good values that may be of little concern to individual water users.

B. The above criteria correspond rather closely to economic efficiency, going beyond the Hicks-Kaldor definition by including a requirement for equity or fairness.

C. We argue that markets meet the above six criteria better than their likely alternatives in many situations, but markets have shortcomings too:

1. Property rights in water are, in practice, difficult to define with precision. Under appropriation doctrine in the western United

States, the right is a usufructory right: a right to use, but not ownership;

2. What constitutes beneficial use changes with time and may even be uncertain at a point in time.
3. Connection of a given use to other users via return flow quantity and quality creates added uncertainty regarding the water right owner's ability to change uses or points of diversion.
4. Market prices may fail to reflect full opportunity costs because of geographical limits to the market and by ignoring negative externalities.
5. Markets may not be as predictable as allocation through long-term contract or through water use licensing, at least not as predictable to those parties who have traditionally received their water under such arrangements.
6. Markets do not guarantee fairness to third parties who may be negatively impacted by a market exchange, e.g. persons indirectly left unemployed as a result of the termination of irrigated agriculture.
7. Markets are likely to understate public good values such as instream flow values because most state laws do not count instream uses as beneficial uses. Idaho, Montana, and Colorado (and now also Utah and Wyoming) allow the state government

to file for or purchase water rights to be dedicated to instream uses (Gardner, 1985; Costello and Cole, 1985). Howe and Lee (1983) have argued that one of the best means of protecting instream flows would be to extend this capability to local governments.

III. Strengthening the Weaknesses of Water Markets

A. The main administrative problem in water markets is the existence of "third-party" effects that take the forms of changed return flows, changed groundwater levels, and water quality changes.

1. The main issue in making markets work more efficiently is to identify and quantify these effects accurately and quickly and to get agreement on their magnitudes so that compensation and/or adjustments to the original property rights can be carried out without excessive transaction costs.

2. In New Mexico the identification of third-party effects is carried out by the State Engineer's office, which also proposed modifications to the right being transferred that should make the transfer acceptable to all parties. In most cases, these recommendations are accepted by all parties. In contrast, the court trial process is

costly, time-consuming, and fails to produce the best analysis of the case. Court modification of rights to prevent third-party damages can result in a large reduction in benefits to buyer and seller to avoid only small losses to third parties.

3. Water law is asymmetric in its treatment of third-party gains and losses in that return flows are considered to be available for reappropriation by others and no payment can be claimed by the creator of the new flow.

B. Another problem in water markets is the difficulty of communication among potential buyers and sellers that results from wide geographical separation.

1. Individual farmers and small towns may have difficulty locating buyers or sellers;

2. Water conservancy districts with professinal staffs may be able to help make markets;

3. Some states are developing satellite-based real time streamflow data systems that should permit the State Engineer's Office to assist in making a market (Simpson, 1984).

4. Such services might be provided by private brokers, but the market is likely to be too thin to be profitable for any group that doesn't already exist for other purposes.

C. A third problem is the protection of those public good values generated by instream flows and higher water quality. In a dynamic setting where town, county, and state governments could buy water rights on behalf of their citizens, these problems would not be as severe as implied by the literature (see Howe and Lee, 1983).

D. Water quality has generally been handled by administrative systems that are totally separate from the allocation of water quantity. In recent years, substantial interest has arisen in the concept of transferable, marketable pollution permits (see Joeres and David, 1983). Under such a system a number of permits for the various pollutants consistent with the specified ambient standards are issued or auctioned to polluters. Thereafter, these permits may be traded within the same pollution basin. Such a system is in use in the Fox River Basin in Wisconsin, the amounts of pollution permitted by each permit being a function of the current assimilative capacity of the stream (O'Neil et al., 1983).

IV. Types of Property Rights in Water and Their Effects on Market Functioning

A. Property rights in water can be completely described only by a definition covering the quantity diverted and consumed, timing, quality, and places of diversion and

application. The more detailed the definition of the property right, the greater will be the heterogeneity among rights. This in turn will increase buyers' search costs and other transaction costs, since markets operate most efficiently when the commodity being allocated is homogeneous.

B. Two main types of ownership rights in water quantity have evolved under appropriations doctrine: priority rights and proportional rights. Priority and proportional systems do have unique advantages in some settings. Table 1 summarizes the comparative advantages and disadvantages of priority and proportional water rights systems.

TABLE 1. A Comparison of Some Characteristics of Priority and Proportional Rights Systems

	Priority Rights	Proportional Rights
General advantage	Different degrees of supply reliability can be purchased	Rights are homogeneous, easier to establish market
General disadvantage	Rights non-homogeneous, more difficult to organize market	Differing degrees of reliability must be created by holding extra shares
When users are alike	Short-run inefficiencies during water shortages	Efficient allocation among users during shortage
When users are not alike	Prevents extreme loss to sensitive users during shortage but generates some short-term inefficiencies due to marginal products not being equal	Either excessive losses to water sensitive users during shortage or sensitive users must hold extra shares
When water supply is highly variable	Protects sensitive investments but results in some short-term inefficiencies	Makes protection of sensitive investments difficult but equates marginal values where users are alike

C. Economic analysis shows that:

1. Optimal water allocation cannot be determined independently from water quality considerations.
2. An optimal water allocation rule is generally neither a priority rule nor a proportional rule.
3. If short term water markets (rental markets) work efficiently, the type of water right may not be important.

V. The Potential for Expanded Markets

A. Flexibility in a water allocation system implies that it is desirable to maximize the scope of the market so that useful transactions can take place over as wide a geographical area and among as wide a variety of participants as possible.

1. The size of the market is limited by transfer costs and by transaction costs, i.e. by the costs of channeling the water from one place to another and of gathering information, putting buyers and sellers in contact, and legally effecting transfers.
2. The tradable margin need not be large to provide the needed flexibility.
3. Since more localized markets such as those within water conservancy districts (WCDs) have been active for many years in the West, some of the

greatest opportunities for increased efficiency lie in interdistrict and interstate markets,

A. An excellent example of efficient market arrangements is found in Northeastern Colorado.

1. The federal Colorado-Big Thompson (C-BT) was started in 1937 and completed in 1957 to bring supplemental irrigation water from the western side of the Rocky Mountains to Northeastern Colorado. The Northern Colorado Water Conservancy District (NCWCD) was established to contract with the federal government for purchase of the water, repayment of project costs, and distribution of the water to final users (see Maass and Anderson, 1978; C. W. Howe et al., unpublished manuscript, 1982). C-BT has provided an historical average of 2.83×10^8 m^3 (230,000 acre-feet) or about 17% of the total water supply of the region. While this supply is primarily for supplemental irrigation, towns and a growing number of industries use C-BT as a raw water supply. This supply represents the easily tradable margin needed to provide flexibility in allocation.

2. The area encompassed by NCWCD included areas of quite different natural water supplies in relation to the amount of arable land. Potential users did not want a mandatory, uniform assignment of water

to the land. These sentiments led in 1957 to a system in which water was to be delivered to the owners of NCWCD shares, a share representing a freely transferable contract between the District and the holder entitling the holder to 1/310,000th of the water available to NCWCD (this has averaged approximately 863.8 m^3 (1.7 acre-feet) of water per year). The transferable nature of the allotments stimulated the creation of a market in which they could be traded.

3. Much of the water needed for urban and nonagricultural industrial growth has been provided by the sale of NCWCD allotments from agriculture. These nonagricultural users often "rent" excess water back to irrigation on a short-term (annual) basis. About 30% of the C-BT water is involved in rental transactions each year, with towns being big renters of water to agriculture.

4. Third-party and instream flow problems have not been solved in NCWCD, but they have been evaded. The complexities and high transaction costs imposed on most water transfers by possible third-party intervention have been evaded because the District has retained title to all return flows.

5. While the NCWCD market arrangements ignore return flow effects, they allow greater flexibility than alternative water distribution mechanisms. Transaction costs are certainly lower than for transfers under state laws, which frequently involve court trials. Flexibility is greater than under some Bureau of Reclamation contracts that prohibit water transfers from specific land parcels. Security of tenure is greater than that found under administrative procedures, such as those found in the Southeastern Colorado Water Conservancy District, where water is reallocated annually by the Board of Directors (see Hartman and Seastone, 1970, Chapter VI). The possibility of easily and advantageously replicating these NCWCD market structures in other project areas warrants serious consideration.

B. The status of potential interstate water sales by either private appropriators or public bodies is in a state of legal flux.

1. It seems clear from Sporhase v. Nebraska (1982) and City of El Paso v. Reynolds that blanket prohibitions of interstate transfers are unconstitutional, but the necessary conditions for legality of sales have not become clear.

2. The answers to many questions are yet unknown:

   a. Must the water be confined to a pipeline?

   b. Is it sufficient that it be part of a larger product (chicken soup or coal slurry)?

   c. Can water sold be allowed to remain in the stream to be abstracted downstream by the buyer?

   d. Can a state government lease part of the water allocated to it under interstate compact but not currently used (e.g. waters unappropriated under state water law or held by the state for state uses)?

   e. Would interstate water leases or sales help affirm the titles to such waters?

   f. Would there be a market for such water?

   g. Against which state's compact allotment would such transactions be counted?

   h. Would California, which has been using waters unused in Colorado and Arizona for many decades, be willing to pay something for a longer-term lease that would assure continued delivery for a known period?

   i. Would the availability of such arrangements eliminate the pressure for nonsensical "use it or lose it" projects?

j. What will be the status of water allocated to the Indian Tribes under federal reservation doctrine and Winter's decree?

C. These questions require timely, objective research and the application of that research to state policy formulation. Recent proposals for interstate leases have prompted uninformed negative reactions for several states.

D. The potential gains from an expanded role for water markets warrant a high priority for research on procedures for expanding their role. The payoff will be much higher than from the continuation of inefficient allocative practices of the past and from the attempts to find ever more new supplies.

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