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**Price Evaluation and Allocation of Water under
Alternative Water Rights Systems - Part II**

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Title

PRICE EVALUATION AND ALLOCATION OF WATER UNDER ALTERNATIVE
WATER RIGHTS SYSTEMS -PART II

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Summary Report of BARD Project US-2507-94C

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Summary Report of BARD Project US-2507-94C

Abstract (*approximately 200 words*)

This project is a continuation of US-2081-91. Together they develop a conceptual and empirical framework to analyze alternative forms of water reform that lead to efficient pricing of water. Our analysis demonstrates that the transition from water rights systems to water trading may lead to improved resource allocation even when overall availability of water resources declines. We introduce two systems of water trading, passive markets and active markets, and show that passive markets lead to efficient resource allocation with lower transaction costs. We demonstrate that both methods of trading are superior to block pricing. We identify the political economic situations that would lead to each type of water resource allocation. Examples from Israel and California are used to demonstrate the conceptual results.

Summary Report of BARD Project US-2507-94C

Objectives

This objective of this project was to develop and apply a conceptual framework to compare the performance of water allocation systems, in particular tiered pricing and various types of water trading schemes. Another objective was to provide a framework to assess the impact of the political power structure on the distribution of water rights and the performance of alternative water allocation mechanisms. This project extended a line of research investigated in a previous study, "Price Evaluation and Allocation of Water Under Alternative Water Rights Systems" (BARD Project No. US-2081-91). Taken together, the results of these projects provide a framework for understanding the transition from water rights to water markets, both in general and in California and Israel in particular.

Background

Water systems that historically have subsidized users and allocated water according to queuing rules are under pressure to become more efficient. Water availability for agricultural districts has declined as demand for competing uses of water has increased and costs have grown. Furthermore, water subsidies have been reduced. As a result, water districts are challenged to redesign their allocation mechanisms in a way that will promote efficiency, be as equitable as possible, and balance the districts' budgets. In Part I of this study we emphasized some of the general issues associated with the system of transition from water rights to water markets. We argued that the transition to water markets would lead to the adoption of modern irrigation technologies, but in order to overcome political economic objections the incomes of single-right owners should not decline with reform. In application we showed that the cost of new legislation in California, in particular the Central Valley Improvement Act, declines as more trading is allowed. These costs are affected more by the extent to which farmers are allowed to trade water than by reduction of aggregate supplies. We also developed a scheme for water pricing over space, an issue that is especially important in the Israeli context, and studied the foundation for modeling specific schemes to induce water trading, including tiered pricing, active pricing, and passive pricing.

Part II of this research was designed to expand on this work. In particular, we aimed to provide rigorous foundations to compare the performance of water trading schemes and to conduct such comparisons within the Israeli context. We also aimed to expand our analysis of water reforms in California and to incorporate political economic considerations for the comparison of the performance of tiered pricing in passive and active markets.

Outcomes

For many years water has been allocated by a quota system. Scarcity has forced water agencies to seek more efficient water allocation mechanisms. Brill, Hochman, and Zilberman (1997a) proposed a rate design for a large class of water agencies (i.e., most water districts in California and Israel), where members have property rights to certain amounts of water based on historical usage. They used this design to address a reduction in overall water use for water agencies. The rate design recognizes that: 1) district directors may not always have complete information about water use; 2) they have to meet zero profit constraints because of the nonprofit nature of water agencies; and 3) to be efficient rate designs have to be "incentive-compatible" in the sense that they must be based on correct predictions of the district members' behavior.

Their analysis identifies two designs that would result in efficient resource allocation. The Hicksian barter market will result in Pareto efficiency if the following conditions exist: information is perfect, trading is costless, and the management allocates "initial endowments" of water according to the historical rights of the farmers. When trading is not costless and information is imperfect, an alternative policy option of "passive trading" with an internal price quotation by the management achieves Pareto efficiency.

The analysis also shows that these two mechanisms are superior to tiered pricing because, under reasonable conditions of tiered pricing without trading, some of the least efficient water users may overconsume. A numerical example using Israeli data showed that tiered pricing will result in 75% of the aggregate welfare level that will be obtained under passive trading.

In another paper, "Multi Sector Water Market-Efficiency vs. Political Pressure," Brill, Hochman and Zilberman (1997b) consider the use of price and quantity to determine overall water allocation for a water agency. This paper examines the relative efficiency of two market mechanisms for water rights, one quantity determined and the other price

determined. In the first, the decision maker determines the aggregate quantity of water rights and market results with the corresponding price, while in the second, the decision maker determines the price and the market results with the aggregate quantity. The paper shows how the results of these two mechanisms differ in bargaining situations. The preferred price-determined mechanism distributes property rights equally, even when users differ in their technological skills. If property rights are distributed unequally but users' skills do not differ, the quantity-determined mechanism is preferred. The results are illustrated by numerical example.

The results of the above two models are generalized to problems of common resources in Brill and Hochman (1996a). This paper argues that allocation of common resources are results of political bargaining. Institutions and legal arrangements (property rights) that are supposed to lead to efficiency with full information and zero transaction costs (the Coase theorem) are doing so in a reality of political bargaining only when political powers are distributed equally among contesting groups. When it comes to management of common resources, governments can affect outcome by determining aggregate quantities or price of the resources. When aggregate quantity is the policy tool, the efficiency depends on the distribution of the property rights. When property rights are not well defined, the efficiency of the allocation process depends on both elasticity of demand and supply. Brill and Hochman prove that when property rights are not defined, using price as a policy tool results in a higher quantity allocation than when quantity is the policy tool.

Zilberman (1996) views water allocation problems within a larger context of agricultural input choices. He argues that, because of the externalities and human capital and informational considerations, agricultural input uses—including pesticides, water, and chemical use—are slowly becoming joint decisions influenced by input suppliers, output purchasers, and consultants. Vertical integration makes buyers of agricultural products and

lenders much more important in lender locations and input use choices. Specialized knowledge requires optimization of resource use and leads farmers to rely more on experts, especially when it comes to small and mid-sized farms. Water agencies can be viewed as nonprofit utilities. Their objective is to obtain water and cover their costs. As water supply conditions worsen, they upgrade their conveyance facilities and provide more technical assistance but limit their water choices. Water utilities are challenged to introduce new water allocation mechanisms that will improve the efficiency of resource use over time. Zilberman asserts that their performance will improve if water laws are changed to allow more flexibility in trading.

Because the empirical emphasis in this project was on the Israeli water situation, some of the conceptual apparatus we developed was utilized to provide the framework for an overview of the Israeli water economy in Brill and Hochman (1996b). Water has been heavily subsidized in Israel for many years, and this policy has resulted in severe water wastage. Drought, the peace process, and the rapid increase of urban demand have increased the need for reforms in the allocation and pricing of water. Water markets have been suggested in the past as an efficient mechanism for water allocation, but there has been little empirical evidence to support this claim. National ownership of land and water, as well as the nature of the settlement process in Israel, prevented creation of Israeli water markets. Privatization of the Israeli water economy has been introduced through quasi-market mechanisms at both the regional and national levels.

At the national level, a Hicksian-type barter market is practiced with given shares of the "initial endowments", while the aggregate water quantity is determined administratively by the central government. At the regional level, a "passive" water trading mechanism is introduced where, at a price announced by the policy maker, each individual uses water according to his demand curve and pays a fine or receives monetary compensation according to his share in the aggregate water right.

These reforms are compared to the current policy of tiered pricing recently adopted in Israel. Data from four different regions in Israel verify the theoretical prediction that tiered pricing results in inefficient allocation. The potential welfare improvement of the market mechanism is calculated to be up to 30% in some regions.

Description of Research

This project extended the methodologies developed in the previous BARD grant, US-208-01-91.

The Economics of Alternative Water Allocation Systems

“Allocation and Pricing at the Water District Level” (Brill, Hochman, and Zilberman, 1997a) developed methodologies to assess the inefficiency loss associated with the use of block pricing and related these efficiency losses to inequality in production. The size of the inefficiency loss is greater as the share of the population with inefficient technologies is greater. The gains from trade under both active and passive markets is related to the distribution of property rights and productivity capacity. If property rights are distributed equally, gains from trade increase with inequality of the distribution of productivity.

Political Economy of Resource Management

In “Multi Sector Water Market-Efficiency vs. Political Pressure” (Brill, Hochman, and Zilberman, 1997b) as well as in “Allocation of Common Resources with Political Bargaining” (Brill and Hochman 1996a), we developed an analytical framework to explain outcomes under alternative institutions in an economy where political outcomes are determined as a result of bargaining processes. This methodology enabled us to relate the political economy weight that characterized outcome of political processes to the weights given to different groups in traditional welfare economic models. The outcome of the political process becomes more inefficient as power distribution is biased towards certain subgroups of the economy. We used this analysis to relate outcome under alternative market designs to outcome under alternative property rights regimes. Political situations

that will prevent the Coase theorem from holding may also make trading outcomes suboptimal.

Policy Reform

In “Institutional and Policy Reform in Water Resource Management,” (Zilberman, 1996), we derived generalized lessons from the experience of water reform in both California and Israel. In both cases, introduction of trading improved efficiency while reducing aggregate supply. Thus, it may be worthwhile to combine reforms that increase efficiency with reforms that increase scarcity. For instance, a policy could reduce overall air pollution rights but at the same time allow for trading of these rights. Another important variable affecting success of a reform is assigning responsibility to government agencies. Agencies that are responsible for certain activities (i.e., maintaining or improving environmental quality) and are resource users should not be in charge of mechanisms to induce trading because of conflicts of interest. Thus, institutional designs have to recognize potential conflicts of interests in assigning responsibilities to agencies.

Quantitative Modeling of Policy Reform

Our analysis in both this and the previous project emphasized the importance of obtaining microlevel disaggregate data to assess the impact of policy changes (Brill and Hochman, 1996b). Heterogeneity among agents is found to be an important empirical phenomena and may be the key to determining the outcome of proposed policy changes. Failure to recognize heterogeneity may lead to unsuccessful policy design.

List of Publications

- Brill, Eyal, and Eithan Hochman. "Allocation of Common Resources with Political Bargaining." In John J. Pigram (Ed.), *Security and Sustainability in a Mature Water Economy: A Global Perspective*. Water and Resource Economics Consortium, Proceedings of an International Workshop, University of Melbourne, February 1996.
- Brill, Eyal, and Eithan Hochman. "The Israeli Water Economy: Reform vs. Reality." In John J. Pigram (Ed.), *Security and Sustainability in a Mature Water Economy: A Global Perspective*. Water and Resource Economics Consortium, Proceedings of an International Workshop, University of Melbourne, February 1996.
- Brill, Eyal, and Eithan Hochman, and David Zilberman. "Allocation and Pricing at the Water District Level." *American Journal of Agricultural Economics*, 1997a, (in press).
- Brill, Eyal, Eithan Hochman, and David Zilberman. "Multi Sector Water Market-Efficiency vs. Political Pressure." Hebrew University of Jerusalem, 1997b.
- Zilberman, David. "Institutional and Policy Reform in Water Resource Management." In John J. Pigram (Ed.), *Security and Sustainability in a Mature Water Economy: A Global Perspective*. Water and Resource Economics Consortium, Proceedings of an International Workshop, University of Melbourne, February 1996.