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A Review

Efficiency of water market and intersectoral water transfer- A macro review and micro analysis

■ **M. Priyanga, S. Achudhan and R. Venkataraman**

Correspondence to :

M. Priyanga
Department of Agriculture Economics, Annamalai University, **Chidambaram (T.N.) India**
Email : priya93.agri@gmail.com

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ABSTRACT : Where water is scarce but demand is growing, water markets offer an opportunity to increase economic efficiency by enabling the reallocation of water among users and sectors. While buyers and sellers willingly enter into such transactions, indirect impacts on agricultural communities can be devastating, as intersectoral transfers may substantially alter the nature of the community's underlying economy. Hence, attempt should be made for the gradual conversion of existing informal water markets into formal market. The emergence of formal markets though considered advantageous in economic perspective the other dimensions like social, cultural, institutional and legal should be bestowed due attention owing to their importance in human life.

KEY WORDS : Efficiency of water, Water market, Intersectoral water, Macro, Micro review

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INTRODUCTION :

Water resources have been experiencing intense and sustained pressure demand from a range of direct and indirect socio-economic driving forces. Although globally, freshwater is abundant, the problem is that it is not available in the right place and at the right time. Arguably the world has been treating water as an almost free resource, despite the fact that competition for raw water is intensifying. Although globally the absolute physical scarcity of water is at best a long term concern, the current management of water resources has been found wanting, with problems relating to inefficient, inequitable and environmentally damaging. While agriculture is often cited as the principal 'user' of raw water, domestic, municipal and industrial uses of water are increasing.

In recent decades India has witnessed rapid growth in demand for water, particularly in domestic and industrial sectors due to population growth, urbanisation, industrialisation and rising incomes. This growth in demand has not been matched by an increase in supply. The problem is compounded by pollution of water, which has reduced its suitability for various uses. At the same time, in traditionally water intensive sectors of the economy such as agriculture, costs of irrigation have increased significantly. Under these circumstances, it is more important than ever before to use water efficiently. It is also necessary to anticipate and address intersectoral conflicts over allocation and use of water. The standard approach so far has been to advocate reform of water pricing across sectors to reflect the scarcity value of water. This advocacy is based on theoretical and empirical evidence on the need and desirability of such reforms including willing-to-pay studies. Nevertheless, major users of water, particularly of irrigation water have resisted these reforms so far.

In this context, economic theory tells us that markets increase economic efficiency by allocating resources to their most valuable uses. In other words, if certain conditions are met, markets provide the correct incentives and lead to efficient resource use. Therefore, one way to change the incentives so that water users support the reallocation of water and to achieving a more efficient allocation of water is through water markets. These allow water users to buy and sell water, thus, changing the whole incentive structure and breaking the log jam of water pricing reforms – when water users can gain from reallocation, they would be willing to sell water or pay a higher price for new supplies.

In an environment of increasing water scarcity, the allocation of water should be at least informed, if not guided (for political reasons), by the full economic value of water in its various uses. When determining the efficiency of water use, as many costs and of water use as is feasible need to be considered. The value of water to a user is the cost of obtaining the water plus the opportunity cost. The latter is given by the willingness to pay for the water in the next best alternative use (in terms of social welfare). For goods and services that are marketed, economic value can be determined using market prices. Methods are available that provide proxy estimates of value for goods and services that are not marketed, though application of many of these is sometimes problematic in the context of developing countries. Water pricing remains a complex process with its own 'political economy' arising from the set of legal, institutional and cultural constraints that condition water resource allocation and management in all countries. Economic efficiency as an objective will often have to be traded off against other decision criteria, but will gain in significance as the full social costs of water service provision escalate.

In a situation of growing water scarcity and rising demands for non-agricultural (household and industrial) use of water, reassessment of sectoral allocations of water are inevitable. In developing countries, irrigated agriculture plays a vital role in contributing towards domestic food security and poverty alleviation. Therefore, achievement of these objectives is dependent on adequate allocations of water to agriculture. Justification of such allocations requires that irrigated agriculture be a cost-effective means of achieving stated political or social objectives, such as food security or poverty alleviation and that all externalities be taken into account in the pricing mechanism. Improved allocation of irrigation water is required within the agriculture sectors of developing countries in order to achieve greater efficiency in the use of irrigation water and existing irrigation infrastructure.

Demand - supply paradox :

Water is a 'bulky' resource. This means that its economic value per unit weight or volume tends to be relatively low. Therefore, its conveyance entails a high cost per unit of volume and is often not economically viable over long distances unless a high marginal value can be obtained. The costs of abstraction, storage and any conveyance tend to be high relative to the low economic value that is placed on the use of an additional unit of water. This can create values for water that are location specific (Young, 1996). A further characteristic of water is that the quantity of supply cannot be readily specified; it is determined by various processes: the flow of water; evaporation from the surface and percolation into the ground. In the case of surface water, supply is determined largely by the climate. Consequently, the quantity supplied is variable and can be unreliable. This can preclude certain uses of water (e.g. the development of water-dependent industries) and affect the value of water in some uses (e.g. irrigation). The quality of water (*i.e.* the nature and concentrations of pollutants) can exclude certain uses (e.g. drinking-water for household use), but have no impact on others (e.g. hydroelectric power generation).

Characteristics of demand for water for irrigation relate to quantity, location, timing and quality. Irrigation generally requires large volumes of water, which can be low in quality. This is in contrast to household use of water, for example, which requires low quantities of water of high quality. The large volumes of water required for irrigation usually have to be transported over some distance to the field. For surface water, canals and pipes can enable conveyance; in the case of groundwater, extraction is provided via tube wells. In terms of timing, demand or irrigation water can extend through the growing season and where adequate supplies are available; extend into the dry season for multiple cropping. Peak demand for irrigation water does not usually coincide with peak flows of surface water. This creates the need for storage capacity, which naturally occurring water bodies (lakes, wetlands and aquifers) or specially constructed dams may provide. Although the quality of water required for irrigation is low, high levels of salinity preclude its use for irrigation and contaminated supplies can reduce the quality of produce (e.g. contamination of horticultural produce with pathogens in polluted water supplies). Agriculture is implicated in issues that concern water quality. Demand for water for non-agricultural uses is increasing in response to economic growth, rising populations and increased urbanization. Rising urban demands for water (for household and industrial use) pose a particular threat to agriculture because urban demands take priority over rural demands in situations of potential conflict. This is because existing urban supplies are usually polluted, they can be associated with high health risks (such as the risks of epidemic diseases), new urban supplies have to come from increasingly distant sources (owing to scarcity in supplies) and the economic benefits of urban water supplies exceed those of rural supplies. Worldwide, withdrawals of water for household and industrial use quadrupled between 1950 and 1995, while withdrawals for irrigation only doubled in the same period (FAO, 2003). In terms of future demand in developing countries, non-agricultural demand for water is forecast to increase by 100 per cent between 1995 and 2025 and agricultural demand to rise by only 12 per cent (given prevailing trends). Rosegrant and Cline (2002) observe that this is the "first time in world history" that absolute growth in non-agricultural demand for water will exceed growth in agricultural demand. It will result in a fall in agriculture's share of total water consumption in developing countries from 86 per cent in 1995 to 76 per cent in 2025 ached Increases in non-agricultural demands for water are coinciding with constraints on further development of new water sources. In combination, these two factors are creating increased water scarcity and they will result inevitably in the transfer of water from agricultural use to higher value household and industrial uses. Urban areas can and do appropriate water supplies from rural areas, resulting in depletion and pollution of surface water resources used by farmers and rural households. In areas of India and the Philippines, water supplies have been diverted from large irrigated areas, seasonally or permanently, to meet urban demand, without any payment of compensation to farmers for resultant losses in crop production (IWMI, 2010). Increases in household and industrial demand for water are expected to result in increases in the scarcity of water for irrigation.

Economically efficient allocation of water is desirable to the extent that it maximizes the welfare that society obtains from available water resources. Welfare in this context refers to the economic well-being of society and is determined by the aggregate well-being of its individual citizens. Economically efficient allocation maximizes the value of water across all sectors of the economy. This is achieved through the allocation of water to uses that are of high value to society and away from uses with low value. Efficient allocation occurs in a competitive, freely functioning market when supply is in equilibrium with demand. Under these conditions, the marginal cost of the supply of water (the cost of supplying an additional unit) is equal to the marginal benefit of the use of water (*i.e.* the benefit of goods and services provided by an additional unit of water). The marginal benefit and marginal cost are the same across all uses and equate with the market price. However, where there are distortionary constraints, such as subsidies or taxes, the maximization procedure will result in a second-best efficient allocation (Tsur and Dinar, 1997).

A feature of economically efficient allocation is that no reallocation can make anyone better off without making at least one person worse off, a condition that is described as "Pareto optimal". The relative efficiency of alternative allocations can be analysed with respect to this, *i.e.* in terms of whether they provide a "Pareto improvement". Although water resources perform many functions and have important socio-economic values, water is in many respects a classic non-marketed resource. Even in its use as a tradeable commodity, market prices are not generally available. The reasons why water has no price are often related to the historical, socio-cultural and institutional context in which water is used and managed (e.g. the return of water use rights for groundwater or surface water on farmers' land). In addition, although water can be captured and shared, water flows can also be recycled. This often makes it difficult to break water down into marketable proportions. An important cause of this economically inefficient water use (where costs outweigh benefits) is the failure of institutions involvement with the allocation and management of water. 'Failure' refers here to institutions where 'they induce or favour decisions that lead society away or prevent society from achieving socially optimal resource allocations' (OECD, 1994). Sources of institutional failure include markets, policies and political and administrative factors. They derive from a fundamental failure of information or lack of understanding of the multitude of values that may be associated with water resources (Turner and Jones, 1991).

Although markets can achieve economically efficient allocation, they are commonly unable to do so. Described as market failure, this occurs through an 'inability of the market to lead the economic process towards the social optimum' (OECD, 1994). Market failure can occur through the non-existence of markets (for externalities and public goods), their failure to communicate necessary information (the social discount rate, society's attitude towards risk and uncertainty), restricted operation of markets (under a monopoly) and inadequate institutions or regulations (absence or non-enforcement of property rights).

For water markets to work, property rights to water must be private, exclusive and transferable (Bauer, 1997). In this context, secure ownership provides an incentive to invest in greater productivity of the resource, while freedom to exchange provides the flexibility to reallocate the rights according to changing demand and other conditions. The role of the state should be minimal in this setting and should be restricted to protecting property rights, enforcing contracts and reducing transaction costs and barriers to exchange. In fact, it can be argued that much of the current inefficiency in the water sector in India is due to excessive state regulation and subsidies, which have distorted patterns of water use. As a corollary then, freer markets would help in "getting the prices right" and in strengthening the incentives to conserve water as demand increases, since any water saved could be sold.

The supply of irrigation water is often controlled by only one agency, a situation described as a monopoly. Under these conditions, the supply of water is not subject to market competition. The supplier determines the price and quantity of water supplies. This can result in inefficient allocations and is a source of market failure. For example, a monopolistic supplier may elect to allocate water between farmers in a manner that does not make the maximum contribution to social welfare. Similarly, the supplier may set the water supply at a level that exceeds the optimum for society (resulting in over abstraction) in order to maximize profits.

Water markets have been in operation in many parts of the world including India. Although informal water markets have been in existence for decades, formal markets with clearly assigned, private and transferable water rights are of relatively recent origin. In Chile, Western USA and Australia, where there are developed formal water markets, there have been significant gains from water trading, particularly from trades between agricultural and urban users as water gets reallocated to more productive uses. In many instances, water trading has alleviated water shortages. International experience also shows that formal and developed water markets strengthen the incentives for conservation and more efficient use of water. For example, farmers have responded by switching to water-saving technologies and high-value, less water intensive crops. The Indian experience with water markets has been positive, although there have been only limited gains as markets have remained informal, localised and primitive. Thus, while these markets have led to some efficiency gains and have expanded the scope for many resource poor farmers to access irrigation, inter-sectoral water transfers have not taken place so far at major proportions. The current challenge in India is, therefore, to establish formal water markets, which will expand the scope of trading and make inter-sectoral water transfers possible. Further, since formal water markets have a legal basis, effective regulation can be designed to address the issue of ecological sustainability. These markets will be of significant relevance to the urban sector, which has been suffering from acute shortages of water, but has not been able to access informal markets. While it is true that in urban areas tariff rationalisation and reforms at the distribution end can improve efficiency in water supply and use, nevertheless, additional measures will be required in view of a fast growing urban population. Formal water markets can provide low cost solutions to augmentation of water supply relatively quickly. In this context, it is estimated that if 5 per cent of the water being used for irrigation is transferred to the urban sector, the latter's water requirements can be met for the next fifty years.

Many authors and indeed experience from real world water resources management, believe that pricing water to manage demand is unworkable in most situations. However, other authors contend that pricing should go further. Thus, Dinar and Subramanian (1997) urge that 'getting the price right' to reflect the social value of the resource is important. Ahmad (2000) maintains that "the economic or political dimensions of water scarcity and its low price mean that agriculture should release water to other uses, because the economic value of water is much lower in farming than for domestic or industrial use". However, Svendsen (2001) points out that winding down the agriculture sector may not be a viable option for governments where there are no alternative forms of employment for farmers. Economic theory cannot override political reality. In practice, the difference in value between using water for irrigation and using it to meet M and I needs, *i.e.* the opportunity cost of irrigation, may not be as high as some argue if the multiplier impact of agriculture on the local economy (the off-farm sector) is taken into account. Furthermore, once M and I demand is fully met, the opportunity value of water drops effectively to zero. Overexploited catchments and water-short areas receive considerable attention, but urban demands in many countries can be satisfied using just 20–50 per cent of available supply in all but the driest years. In these situations, the permanent transfer of water from agriculture to other sectors would be counter productive. Legal provisions, ensuring that agriculture would surrender water to urban needs in the occasional dry years under a system of seasonal allocations, would be a better approach than one reliant on the vagaries and complexities of the market. In overexploited catchments, negotiated reallocation may be the best solution.

The views summarised above are in fact contradictory. One group believes that determining financial prices such that demand will equal supply is unmanageable; the other believes that prices should embody not only the influence of financial market forces, but also social, environmental and broader economic considerations.

Tradable water rights go some way to bridging this gap: rights to use water are assigned to individual beneficiaries, ranging from farmers to towns to environmental uses, navigation, etc. Those wishing to buy or sell water do so through a regulated market, which monitors examines third party impacts and controls the transfer of rights to eliminate negative third party effects. This allows security of supply to users, the option to enter the market – and hence, generally improve water allocation – and the possibility for the state to enter the market to purchase water for environmental or social purposes. Users thus become aware of the value of the resource they are using.

The World Bank's Water Resources Sector Strategy gives strong support for the role of water markets as a means of ensuring that users understand the opportunity cost of water to different sectors. However, it should be clear that farmers need to have a legal entitlement to a water right, which they are able to trade. Leaving aside the institutional requirements, water trading requires infrastructure to move measured volumes of water between potentially distant parties.

Water markets in India:

Water markets that exist in India are informal and are generally limited to localised water trading between adjacent farmers, and the practice is quite common especially for groundwater. The extent of area irrigated through water markets, which is often considered to be a surrogate for the magnitude of water trading, varies across regions as well as over time depending on a number of factors such as rainfall, groundwater supply, cropping patterns and the cost and availability of electricity (Saleth, 1994). In water scarce pockets of Gujarat, Tamil Nadu and Andhra Pradesh, a substantial area is irrigated through groundwater markets. A review of the functioning of informal water markets in India can improve our understanding of the market and provide useful insights, which could form the basis for designing formal markets.

Water markets in India are mainly limited to the irrigation sector – that is, one irrigator selling water to another irrigator. Water trading in India is localised, fragmented and are over short distances and periods. The emergence of groundwater markets typically depends on rainfall, groundwater supply, availability and cost of energy, cropping pattern etc. Most water sales do not involve any reduction in irrigation by sellers (Saleth, 1997). Most of the sellers are large farmers owning deep wells and large capacity pump sets and the buyers are usually small farmers without wells or pump sets, though there are non-poor farmers who rely on groundwater markets due to farm fragmentation or inadequacy of water in own wells. By providing access to use of groundwater and irrigation assets to resource-poor farmers, groundwater markets have promoted equity. The existing informal markets are small and unbalanced and are typically characterised by a weak bargaining position for buyers. Buyers often do not have a choice because of low density of wells, compounded by uneven topography and potential for seepage losses (Shah, 1993), which gives sellers a degree of monopoly power. Further, there is evidence of buyers being tied down to sellers from contguous plots, as sellers can and do refuse conveyance of water through their plots to other possible suppliers (Janakarajan, 1993 and 1994). Monopoly power helps sellers not only in raising prices but also in compromising the quality of service they offer. Social factors and agrarian relations sometimes determine the development of water markets. Terms of water payment vary widely and differ by crop and by season. Payments can be made through cash transaction or non-cash contracts. Cash payments are made on the basis of time, volume or area irrigated. There is some evidence of decline in groundwater table caused by competitive water withdrawal due to intense water marketing activities (Moench, 1992). Under the current legal system, there is 'open access' to groundwater and the access to groundwater is governed by *De facto* water rights system (see below). As long as this is the case, over exploitation of groundwater cannot be avoided, since water price tends to reflect pumping costs and other related factors and does not fully capture the scarcity value of groundwater. The problem is compounded by electricity and diesel subsidy. In addition to reducing ecological sustainability, one important side effect of this phenomenon is that poor farmers who do not have the resources to deepen their wells are driven out of farming. The regulatory response, which has been in the form of well spacing and depth norms, has largely failed. Besides, since these norms can take effect only when a farmer applies for a concessional loan or well permit and electric connection, they mostly restrict resource-poor farmers, thereby raising questions about fairness.

Performance of water market – An empirical study:

With the above reviewed aspects and insights on water markets from the key papers cited in the reference an empirical study was attempted to observe the performance of water market at micro level. A field survey was undertaken among the groundwater use farmers in Keerapalayam block of Cuddalore district, Tamil Nadu. A size of 30 sample respondents was contacted in the village's vicinity to urban centres in the selected block. The study revealed that among the sample farmers 43 per cent used water only for their own irrigation purpose and 47 per cent resorted to water selling. In water selling option again the selling water for irrigation purpose had a major share (40%) followed by urban construction and domestic use.

The location proximity of the selected villages to the nearby urban centres might be the determining factor for the farmer's water selling option. Again the demand and supply characteristics of water in the urban centre will also play a crucial role. The selling and buying option on irrigation purpose is characterized with the availability of water quality and season. Paddy (Sept-Dec) –Black gram (Jan-March) was the cropping sequence of these sample villages. Majority of the paddy farmers who have purchased water for irrigation purpose demanded water only for raising nursery anticipating the canal water for

Table 1: Stratification of water selling to sectoral use in sample farms in Keerapalayam block of Cuddalore district

Sr. No	Sector	No of farmer	Percentage	Average size of holding in ha
1.	Own agricultural use	13	43.34	1.92
2.	Selling water for irrigation	12	40.00	1.88
3.	Selling water for domestic purpose	3	6.66	1.43
4.	Selling water for construction and other urban uses	4	10.00	1.56
	Total	30	100	1.70

Source: Field survey

Table 2 : Water pricing prevailing among the sample farmers in Keerapalayam block of Cuddalore district

Sr. No.	Cost/ selling price	Cost	Price	Value
1.	Own purpose	10/hour	16/hour	13000/season (30% of the gross income as
		9000/season	15000/season	per factor share analysis)
		4.5/10000 litres	8/10000 litres	
2.	For irrigation	50/hour	250/acre/irrigation	Should be estimated by Willingness to pay
			6000/season (1/5th of the yield)	
3.	For domestic use (Drinking)		1500/6000lit	Should be estimated by Willingness to pay
4.	For construction		650/6000lit	Should be estimated by Willingness to pay

Source: Filed survey

their main field. These farmers though owned their own tube well, due to unsuitable salty water quality of their own well they opted for water purchase.

Water pricing practices of the sample farmers:

A simple percentage analysis was done on the data gathered through the interview schedule. The cost was worked out by annual amortized method taking the investment pattern, imputed value for electricity included and presented under price column for own use).The other technical detail such as motor HP depth of tube well, pumping efficiency were taken to work out the per hour and per acre costs. The factor share analysis was used to work out the value of water which was 30 per cent as per the cost of cultivation estimates in the study area.

The Table 2 reveals that the cost was water at subsidized electricity price is one and a half times lesser (9000/season) than its original cost (15000/season). But the cost with imputed value of electricity (15000/season) was higher than its value (13000/season) which justifies the rationale of the subsidy component. More over this should be discussed with input-output price parity. The water selling price for irrigation purpose was lesser (6000/season) than the farmers original cost, price and value (9000, 15000 and 13000, respectively). This might be due to the unrealised implicit fixed cost incurred by the water seller in the first case whereas it takes into account the output prices, willingness to pay by the buyer and the price of water prevailing in other sectors in all other cases. The price of water in other sectors is much higher compared to agricultural uses. The fact here is that agriculture demands higher quantity and less quality whereas the urban sector demands less quantity with higher quality and this may be one among the reasons for this price disparity. Hence mostly the empirical analysis supports most of the reviewed past studies in water markets. In line with this the following concluding remarks were drawn.

Concluding remarks:

Water markets have been in operation in many parts of the world including India. Although informal water markets have been in existence for decades, formal markets with clearly assigned, private and transferable water rights are of relatively recent origin. The current challenge in India is therefore to establish formal water markets, which will expand the scope of trading and make inter-sectoral water transfers possible. Further, since formal water markets have a legal basis, effective regulation can be designed to address the issue of ecological sustainability.To ensure this firstly, it is important to estimate the full cost of water used in a particular sector and this should include the opportunity cost of water as well as the environmental externalities. The full cost should present the context for setting water prices, effluent charges and incentives for pollution control; Secondly, in estimating the value of water, it is critical to reflect societal objectives of poverty alleviation and food security and incorporate the net benefits from return flows and non-irrigation uses of water. The third point is that, the above considerations should be taken into account while setting water tariffs for domestic users and for irrigation. Finally, raising water tariffs, levying effluent charges and encouraging water markets can play significant roles in improving economic efficiency and environmental sustainability of water use.

Authors' affiliations:
S. Achudhan, Department of Agricultural Economics, Tamil Nadu Agricultural University, **Coimbatore (T.N.) India**
Email: achudhanageco@gmail. com

R. Venkataraman, Department of Agricultural Economics, Annamalai University, **Chidambaram (T.N.) India**
Email: rvauagecon@gmail.com

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