ESTIMATING THE ECONOMIC VALUE OF IRRIGATION WATER: THEORY AND MARKET REALITY IN NORTHERN VICTORIA

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Methods of estimating the economic value of irrigation water are reviewed and discussed in the dual contexts of sustainability and market failure in the provision of public goods. Financial viability in the water sector requires the ability to pay all costs including long run, environmental and resource protection costs. The wide disparity between the market price for transferable water entitlement and the capitalised estimates of economic value indicates either that there are gross deficiencies in most methods of estimation, or that there is a case for the use of regional and national multipliers in the evaluation of large scale developments.

1. Introduction

This paper is an attempt to reconcile theoretical estimates of the economic value of water with the market prices revealed by trade in water rights in Northern Victoria. This reconciliation is important in the light of the current emphasis on the development of sustainable self funding irrigation in the Murray-Darling Basin (MDBC, 1993). To carry out this task it is necessary establish the categories of relevant costs required to produce the sustainable benefits of irrigation. Once these categories are quantified, judgements regarding the on-farm profitability of sustainable irrigation are possible. Given some idea of farm profitability, and its relationship to fluctuating commodity prices and business structure, it is possible to make some estimate of the annual contribution irrigated agriculture can make toward the funding of public irrigation schemes. This is useful knowledge for decision makers contemplating investment in new or existing schemes.

2. Categories of Costs and Residuals

2.1 Variable Costs

These costs can be avoided by not producing or not harvesting a commodity. Fertiliser and fruit picking are examples. In the very short run it does pay to produce even if income just exceeds variable costs.

<u>Gross income minus variable costs leaves a gross margin</u>

2.2 Cash Overhead Costs

These fixed costs must be paid to operate the business even if no output is produced. Annual costs such as vehicle registration, shire rates and a living allowance for the operator are typical cash overheads.

2.3 Capital Costs

These are fixed costs which must be met to maintain the productive capital base. Depreciation of plant, irrigation layout and infrastructure costs and the required return on capital are examples.

2.4 Resource Protection Costs

These are costs incurred to maintain the inherent productive capacity of resources. These costs may be fixed or vary with production or resource use intensity.

For sustainability, gross margin must exceed overhead, capital and resource protection costs.

3. A sustainability perspective required by evaluators.

Provision for replacement of depreciating assets used in the production process and a capacity to develop and adopt new technology to substitute for consumption of stock resources and enhance efficiency are essential requirements for sustainability. Thus a policy view using short run marginal analysis which ignores long run costs is a deficient instrument for development of a sustainable resource management policy. While the short run view may be suitable to guide a more efficient allocation of variable inputs, it cannot indicate the likelihood of sustainability because the surplus required for overhead requirements is not taken into account. When long run (or even mid run) costs have not been taken into account, the analysis is incomplete and overestimates the net revenue arising from sustainable irrigation. This overestimation leads to a number of misleading conclusions which are at odds with market reality. Unduly over-optimistic estimates of the economic rent derived from public irrigation are developed leading to flawed policy advice and reduced economic efficiency and reduced net social welfare. Over-estimates of the net economic return may lead to expansion of irrigation beyond the sustainable optimum and public subsidy being required for financial viability. With pressure on for "user pays" management of public schemes, overestimation of the value of irrigation water (and the persistent notion that current irrigators derive large annual economic rents) will result in much larger pressures for structural adjustment than expected.

The rationale for benefit:cost analysis and for prudent commercial investment appraisal requires that all costs are taken into account.

4. Optimism and Pessimism, Development and Hardship

Deduction of long run costs from gross margin reduces the perceived "profitability" of irrigation projects. Perhaps this is why "enthusiasts" promoting irrigation have chosen to underestimate or neglect long run costs in their analysis (and even in some cases omit variable costs as well (Clark, 1967 [1]). Optimistic *ex ante* evaluations have led to financial failure and social hardship because settlers taking up irrigated land made available by state funded schemes were unable to service their debts assumed on the expected benefit of irrigation, even at concessional rates of interest available to soldier settlers. This situation is described for early schemes by Davidson (1967) where "the Pike judgment of 1926 established the principle that a farmer could only repay from the profits he earned, and that this was not related to the cost of supplying him with water."

One current locus of apparent enthusiasm regarding profitability lies in the area of irrigation management policy. This at first seems rather surprising in view of the long history of government subsidy of "national development" public irrigation schemes so strongly criticised by Davidson (*op. cit.*). Perhaps it is understandable considering the current emphasis of microeconomic reform aimed at self funding of infrastructure by direct beneficiaries. The Pike judgement in favour of settler Batkin serves to emphasise the structural instability of schemes founded on optimism. The structural adjustment implications of microeconomic reform in the water sector will need to be kept in mind. Soundly based estimates of business profit will assist development of plans for structural adjustment.

5. Reconciliation of Market Prices for Water Right and Theoretical Estimates of Economic Value of Water

5.1 Economic Value of Water

A number of studies and/or surveys have attempted estimation of the economic value of irrigation water. Generally the average value for economic gross margin is around \$50/Ml in 1989 currency (Hickey and Lloyd, 19665; Ferguson *et al.*, 1979; Briggs Clark *et al.*, 1986(BAE); Read and Sturgess, 1991(DWR); Anon., 1991; Gyles and Young, 1992). There is variation but this is secondary in terms of the issue to be developed here.

The BAE and DWR studies used linear programming under constrained optimisation to develop schedules of gross margin. Graphs of the results have been described as short run demand curves. The modelled allocation of water and estimated gross margin for northern Victoria taken from the DWR study carried out by Read and Sturgess (*op. cit.*) is shown in Figure 1.

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[1] "Some advocates of irrigation not only fail to understand economics, but the simplest principles of accounting as well, and are unable even to distinguish gross from net returns."

ALLOCATION OF GROSS MARGIN

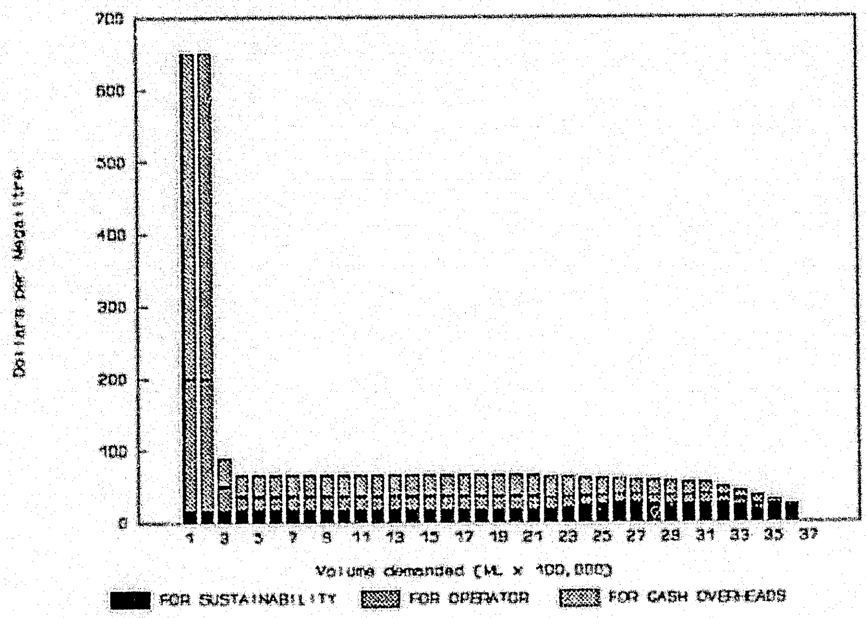

Figure 1: Gross margin schedule for water use in northern Victoria in 1989 with apportionment of operator's allowance and cash overheads.

5.2 Market Prices

5.2.1 What is Being Traded?

Water allocations have been abundant since the introduction of transferable water entitlement (TWE). This means that holders of permanent water right have been able purchase more than one megalitre for each megalitre of water right held. The allocation varies from district to district and from season to season but allocations were restricted to 130% of water right during the 1982-3 drought. In recent years allocation has been greater than 200% on application. This usually means that storage capacity is high in relation to demand. Seasonal climatic factors tend to exaggerate the relationship.

Prices paid for water right will depend on the buyer.s expectation of net surplus. Because of the heterogenous nature of water rights due to temporal and locational variability in terms of institutional arrangements, prices for inputs and commodities, and climate, there may be considerable dispersion in market prices (Colby *et al.*, 1993).

5.2.2 Temporary Transfer

The price of water right traded under temporary TWE has tended to lie between the compulsory annual supply charge and zero (pers. comm. Transferable Water Exchange, Tatura). Trade makes each party better off. The water supply authority sells less "sales" water.

5.2.3 Sale of Water Right and Permanent Transfer

Auctions of water right for river pumping licences were held by the Rural water Commission (RWC) in 1989. Prices paid varied from $750/Ml for small lots (10 Ml), to $100/Ml for larger volumes (40 Ml upwards)(Simon and Anderson, 1990). Similar auctions of water right were held in central Gippsland in 1993 when prices for the bulk of the volume offered were around $160/Ml (pers. comm W. Stent).

The price of water right permanently transferred using TWE since 1992 has ranged from $300/Ml to $400/Ml (Jones and Young, 1992). Recent prices have ranged from $250/Ml to $300/Ml (pers. comm. Transferable Water Exchange, Tatura).

5.3 Capitalising annual economic value and annualising market prices for permanent water right.

The appropriate interest rate to use for long term investment in sustainable agriculture is fairly low. Quiggin (1991) has suggested rates around 3% to 5%. Donnet (1982) reports approximate real rates of return ranging from -4.3% to 7.6% over the 1976/77 to 1981/82 seasons.

Taking 4% as an appropriate rate (perhaps on the high side) to capitalise an economic gross margin of $50/Ml results in a capital value of $1250/Ml. No wonder irrigation optimists and short run policy analysts think there are enormous rents to be captured!

After assuming that the water buyer's expectation of annual allocation will be 1.5 Ml/Ml of water right, the market valuation of annual profit per megalitre of irrigation is $8/Ml. This is in line with the profitability estimated by Dakis (1990) using partial budgets.

5.4 Gross Margin and Value Marginal Product (VMP) and the Jump to Willingness to Pay (WTP).

The notion that the gross margin for water is equivalent to the VMP, and thus the efficient level for prices, has beguiling simplicity for irrigation policy analysts. Another view using the same short run perspective, would be that, at the margin, the cost of producing another megalitre of water in most seasons is zero. And thus the price should be zero. There is a need to combine the long run and short run scenarios when developing water policy. Figure 2 shows the financial situation on a hypothetical irrigation farm with annual overheads of $40,000. Two gross margins are shown relating total water use and operating surplus. Until a large enough volume of water has been used to generate sufficient gross margin to pay overheads there is no surplus. Thereafter there is surplus available for apportionment to consumption, accumulation of productive capital or payment of increased prices for water. To treat the gross margin from every megalitre of water use as producers surplus (economic rent) or as consumers surplus and thus WTP is theoretically incorrect and absolutely misleading in terms of long run sustainability. Better knowledge of farm business structure, water use efficiency and all farm costs are needed to guide water policy formulation and tariff structure setting. The implications of commodity price fluctuations and increasing technical efficiency are obvious.

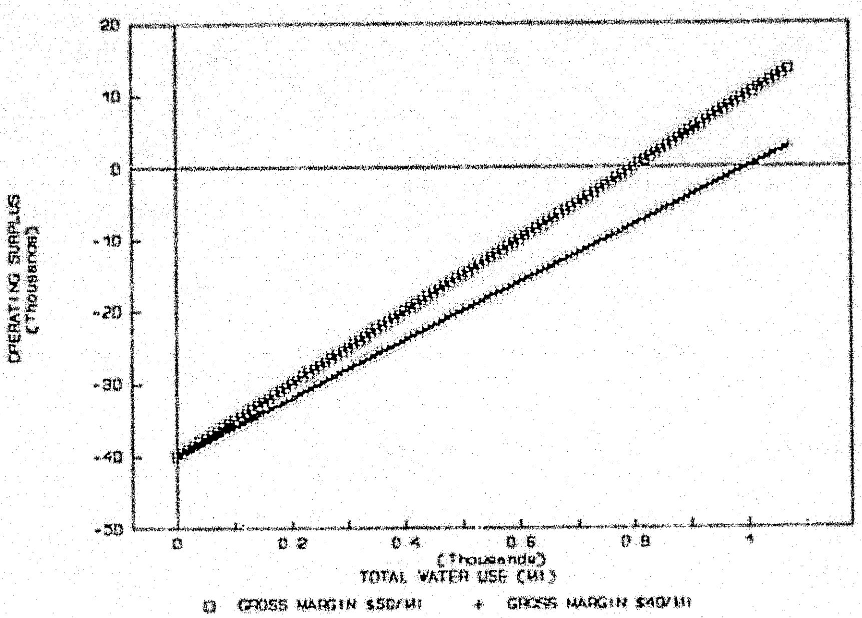

Figure 1: **Relationship between gross margin per megalitre of total water use and operating surplus.**

6. Commodity Futures and Demand for Irrigation Water

In Figure 1, the top of the histogram shows the gross margin per megalitre of total water use produced by succeeding volumes of irrigation water. Starting from the left, high gross margin per megalitre is produced by horticulture using a small proportion of water supplies. The bulk of the water is used for dairy pastures with more extensive grazing industries using the balance and producing the lowest gross margin per megalitre.

On the basis of gross margin, an increase in demand for horticulture would cause water to move to horticulture from extensive pastoral areas. This sits well with the conventional notions regarding the future pattern of irrigation. However, since overhead and capital costs must be met to enable a sustainable future, these should be deducted from gross margin to give some estimate of long run demand. When this is done, it is seen that horticulture has high cash overheads and operator's allowance per megalitre when compared to pasture based enterprises (Monticello, 1992; Anon, 1991a; ACIL, 1989).

On the basis of cash per megalitre remaining to service capital and resource protection costs, there is little effect of commodity type on demand for water. That is to say, the long run profitability of production was much the same for all commodities. This is intuitively reasonable, for otherwise there would have been large scale shifts of resources to the more profitable enterprises. (In 1988/89, high wool prices were causing higher demand for irrigation w ter than horticulture.)

Expected commodity and input prices are important factors in estimating demand for irrigation water.

7. Potential for Investment in Increased Productivity and Resource Protection

The cash residual of $15 - $20 per megalitre can be viewed against expected capital and resource protection costs. Consider the dairy industry. Capital investment in a dairy farms is approximately $700 per megalitre of total water use (Greenaway, 1989).

Labour efficient dairy pasture layout costs of up to $2500 per hectare (pers. comm. Planright Tatura, 1992) with 50% residual value after 25 years annualised at 4% with 12.5 megalitres per hectare total water use works out at $10.40/Ml.

Depreciation of dairy plant costs exceed $15 per megalitre (Greenaway, *op. cit.*).

Salinity, drainage and nutrient management may cost $5 - $15 per megalitre (Young, 1992).

There is insufficient surplus to fund both productivity improvement and resource protection. Therefore productivity investment must be profitable to enable funding of resource protection.

8. To Multiply or not to Multiply?

Where there are opportunity costs for primary resources devoted to irrigated agriculture, these must be taken into account in an economic benefit:cost analysis. For large projects, or significant policy changes, it may be appropriate to model secondary effects in a general equilibrium framework (Anon, 1991b). In this case varying multipliers for different project possibilities could be taken into account. If multipliers are used to justify claims that the economic value of irrigation water is $50/Ml, it would be appropriate for secondary beneficiaries to pay a share of the cost of water resource development.

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