Incorporating Marginal Costs in Water Supply Tariffs: Prospects for Change

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Introduction/Context

Academics and policy makers have widely acknowledged that the price of water has been substantially below the cost of providing water services (Rogers et al, 2002). Pressure on utilities’ budgets has led to a growing acceptance of the need for Full Cost Recovery (FCR). Today, in most developed regimes at least, customers are expected to pay for the costs of their water services.

The widespread acceptance of FCR has brought with it a new pricing challenge – not just ensuring that customers pay for the services that they receive, but that customers consume an efficient quantity of water services. Utilities adopting more expensive technologies at the margin (such as the expansion of desalination plants in Australia) may have incremental costs far outstripping their historical average costs of service and the prices they charge to customers. Moreover, rising water scarcity, increasing bills and economic pressures on the population as a whole have resulted in increasing scrutiny of tariffs, even in water-rich jurisdictions like the UK.

Economic theory suggests that marginal cost pricing is the key to ensuring customers make efficient consumption decisions. In the water industry, which requires significant upfront investment for long lived-assets, the marginal cost concepts can be difficult to apply. Two main methods for incorporating marginal cost signals into price-setting have emerged in the literature, which we shall call the “Turvey” approach (also known as the ‘perturbation approach’) and Average Incremental Cost (AIC) approach.
These long run marginal or incremental cost concepts are not purely theoretical approaches for setting prices favoured by economists: Regulators internationally, particularly in Australia, have begun to adopt these marginal cost concepts as a method for setting tariffs and encourage efficient consumption. Although the Turvey approach has stronger theoretical underpinnings, regulators have mostly implemented AIC approaches for reasons of computational simplicity.

The distinction between marginal costs for the purpose of setting prices and cost concepts used more widely is important here. The forward-looking Turvey approach and AIC approach may not be the only relevant cost standards for calculating marginal costs, for example in other contexts, where specific legal standards may apply. This paper focuses its attention on tariff-setting and the implications of marginal cost concepts for economic efficiency. We begin by outlining the need for long run marginal costs in setting prices, go on to discuss how to calculate each of these approaches and finally describe how these approaches have been implemented in practice.

Why Use Long Run Marginal Costs for the Water Sector?

Economic theory, roughly speaking, states that markets are an efficient mechanism when prices are set equal to the cost of producing one more unit of output, known as “marginal cost”. (This result, the First Fundamental Theorem of Welfare Economics, requires a number of caveats and assumptions, excluded here for brevity; for reference, see any standard micro-economics textbook.)

The cost of producing one more unit of output depends on the time period concerned. Short Run Marginal Cost (SRMC) describes the cost of meeting an additional unit of water demand, keeping capacity constant, whereas Long Run Marginal Cost (LRMC) relaxes this constraint and allows supply-side capacity to be varied.

In principle, prices could reflect either SRMC or LRMC. Indeed, if capex could be split into very small projects, SRMC and LRMC would converge (see Turvey, 2000). In practice, in industries like the water industry, capex tends to be “lumpy” and consist, at least in part, of significant upfront investments. In such circumstances, SRMC and LRMC may not be equal, and SRMC may not be a reliable basis for setting water tariffs, because:

- **SRMC is more volatile than LRMC**: SRMC can rise as high as the costs of cutting off (the value of lost load). High and volatile prices may not provide a credible method for charging consumers/financing water utilities.

- **Costs of reflecting SRMC in prices are higher than LRMC**: In order to reflect SRMC accurately in prices, prices would have to vary on a short-run basis. That would require a wide roll-out of smart water meters, which, in the first instance are not there, and, in the second instance, may not justify the investment costs.
• **SRMC pricing may incentivise fewer investments to reduce consumption than LRMC:** Many methods of reducing consumption of water take the form of long-term investments such as households’ investment in water-using appliances, such as dual-flush toilets, or industrial users’ locations. If consumers are not fully rational or have limited access to credit, they may not make investments to reduce exposure to volatile peak-time prices.

Accordingly, regulators and companies in the water industry use long-run cost concepts, such as the “Turvey” and AIC approach to provide marginal cost signals through tariffs.

### The Turvey Approach to LRMC

The Turvey approach, named after Ralph Turvey (Turvey, 1969), estimates the cost of serving an additional increment in demand. The analyst takes the following steps (see Figure 1):

- **Step 1:** forecast supply and demand under the optimal expansion plan for the water utility;

- **Step 2:** hypothesise a permanent increment (or decrement) to the expected demand forecast, and estimate a new optimal expansion plan in light of that increment (or decrement); and

- **Step 3:** calculate the LRMC as the change in the present value of expenditure in step 1 and step 2, divided by the present value of the hypothesised increment (or decrement) in expected demand.

If the underlying investments undertaken do not change between step 1 and step 2, the Turvey approach boils down to calculating the additional interest costs of bringing investments forward (back) over time to meet demand at lowest cost. Of course, it may be possible to reduce the cost of meeting the additional demand further by optimising the types of infrastructure investments for the higher demand level.

The Turvey approach is very close to the marginal cost concept and has economic theory on its side. However, in practice, the Turvey approach can be informationally intensive. For example, the results are sensitive to the forecast of demand and defining two optimal expansion plans into the future. If demand does not materialise as forecasted, then the prices calculated could be significantly out of line with the actual marginal costs incurred.

Similarly, marginal costs under the Turvey approach can be very sensitive to the hypothesised increment to demand. In some instances, where the hypothesised increment has a natural interpretation, such as the water demand of an additional customer of a particular type, it may be simple to decide on the increment. In other cases, the increment size may be subjective and the choice of that increment may have a large impact on the estimated marginal costs.
The AIC Approach

The AIC approach estimates the average cost of meeting future demand. The analyst takes the following steps (see Figure 2 below):

• **Step 1:** forecast the costs of serving demand including anticipated growth under the optimal expansion plan for the water utility (i.e. the same as under the Turvey approach);

• **Step 2:** forecast costs *without* demand growth; and

• **Step 3:** calculate the LRMC as the change in the present value of expenditure in step 1 and step 2, divided by the present value of additional demand served.

The principal shortcoming of the AIC approach is that it uses *average* capital costs to approximate the likely marginal costs associated with a change in demand. Specifically, the AIC approach does not explicitly consider the water supply capacity associated with marginal capital projects. Rather, the AIC approach averages the cost of future projects by dividing by the present value of the change in demand supplied by them without discriminating between the “size” of individual projects. The implication of this is that the estimates of LRMC under the AIC approach can depart quite significantly from the “true” underlying LRMC.
Turvey and AIC in the Water Sector

There are no established rules regarding which of the two methods results in higher or more volatile cost estimates and no general “equivalence” theorem of convergence for the two approaches. In practice, the choice between the Turvey approach and the AIC approach requires consideration of a number of factors:

- **Theoretical Robustness and Stability:** Both approaches seek to estimate the incremental cost of output. From a theoretical standpoint, the Turvey approach has the edge over the AIC approach because it estimates the marginal cost of incremental output, whilst the AIC approach estimates the average cost of incremental output. On the other hand, as an average cost concept, AIC may offer greater stability in prices.

- **Informational Intensity and Subjectivity of Inputs:** Both the Turvey and AIC approaches require the choice of subjective parameters, including the reliance on expectations (i.e. demand forecasts) and unknown parameters that have to be estimated such as the appropriate private or social discount rate. The Turvey approach requires an extra degree of subjectivity in that it requires the utility or the regulator to forecast additional optimal expansion plans, with and/or without a hypothesised increment to demand.

- **“Lumpiness” of Capex:** In circumstances where the marginal capex for a system is relatively “lumpy”, the AIC approach leads to a large amount of “spare” capacity entering into the marginal cost calculation under the AIC approach. In circumstances where system capacity is expanded more “smoothly” as demand increases, the AIC serves as a better approximation of the underlying marginal costs than when capex is lumpy. This is because the extent of “spare” capacity is significantly reduced (as illustrated by the red triangles in Figure 3 below). The Turvey approach often largely consists of the interest costs of bringing forward capital projects, and may therefore be less sensitive to the “lumpiness” of capex.
International Precedent

Both the Turvey and the AIC approaches have been implemented internationally. Despite the theoretical benefits of the Turvey approach, regulators have mostly chosen to use the AIC approach on the basis of computational simplicity. Some of the most developed and interesting examples are in Australia, where there is a rise in the need for desalination and periodic water shortages, but we also refer to the largely abandoned workstream implementing LRMC in England and Wales. We summarise these case studies in Figure 4.
**Western Australia**

In Western Australia, the Economic Regulatory Authority (ERA) conducts periodic inquiries to recommend tariffs to the state Minister for Water, who approves tariffs for the water companies (ERA, 2009). The ERA has applied a mixed and somewhat inconsistent approach. As part of the ERA’s 2005 price inquiry into the tariffs of the Water Corporation, the company used a Turvey approach to estimate the LRMC of supplying water and an AIC approach for estimating the LRMC of wastewater services as part of its regulatory submissions (Allen Consulting Group, 2005). In a contemporaneous inquiry, the ERA selected an AIC approach to estimate the LRMC for Aqwest and Busselton Water. The ERA provides no material explanation for its mixed approach in the 2005 inquiries or in the 2009 inquiries that followed.

**New South Wales**

In New South Wales, the Independent Pricing and Regulatory Tribunal (IPART) is responsible for determining the maximum prices that can be charged for metropolitan water, wastewater and stormwater services as well as for services related to bulk water services, including water resource management. IPART first used LRMC estimates as part of its 2005 metropolitan price determination. At the time IPART decided to use the AIC approach on the basis that it provided simpler estimates that were less susceptible to small changes in assumptions (IPART, 2005). IPART has continued to use the AIC approach to calculate LRMC for the Sydney Water determinations in 2005 and 2008, the recent 2009 determinations for the Central Coast councils as well as the 2009 determination for Hunter Water Corporation (IPART, 2009).

**Queensland**

In Queensland, while the Queensland Competition Authority (QCA) has wavered between the Turvey and AIC approaches.

- In December 2000, the QCA published its pricing principles for the water sector, concluding that volumetric charges should be set equal to AIC (QCA, 2000).

- As part of its Final Report on the pricing practices of the Gladstone Area Water Board (GAWB) in September 2002, the QCA changed its mind in favour of the Turvey approach on the grounds that it more closely reflects incremental costs (QCA, 2000).

- During its investigation into the pricing practices of the Gladstone Area Water Board in March 2005, the QCA changed stance again on the most appropriate methodology for estimating the LRMC. Noting its earlier conclusion that the Turvey method provided a more appropriate estimate of LRMC than the AIC, the QCA advocated using the AIC approach on the basis that it would provide more stable prices that were more transparent and on the grounds of computational simplicity (QCA, 2005).

Overall, as part of the 2005 investigation into the pricing practices of GAWB, the QCA recommended that LRMC be estimated using the AIC methodology. The QCA has retained this approach at all subsequent pricing investigations.
South Australia
The Essential Services Commission of South Australia (ESCOSA) is the economic regulator in South Australia for the monopoly supplies of urban water and sewerage services. ESCOSA has, perhaps, used the least sophisticated calculation of LRMC in setting prices of the Australian regulators we reviewed. In its 2009-2010 pricing decision, ESCOSA stated that it set charges consistent with SA Water’s own estimate of LRMC, based on an AIC approach (South Australian Government, 2009). SA Water estimated the AIC of a single future project -- the potential expansion of the planned Adelaide desalination plant from 50 GL to 100 GL. SA Water has used the same methodology at subsequent reviews. ESCOSA has complained about the lack of transparency in SA Water’s calculation, but has not gone so far as to propose moving to the Turvey approach (ESCOSA, 2010).

Melbourne, Victoria
The Essential Services Commission of Victoria (ESC) is responsible for the economic regulation of the water sector in Melbourne. As part of its review of water and wastewater prices to be charged from 1 July 2005, the ESC emphasised the importance of setting variable prices according to estimates of the LRMC of supply, but noted that the businesses were not doing so at that stage (ESC, 2005). The ESC consulted with water businesses on the methodological issues associated with estimating LRMC and released an Information Paper in September 2005, the purpose of which was to serve as a manual to which businesses could refer to when demonstrating that they had estimated the LRMC of their various services and had had regard to those estimates in setting their variable prices (ESC, 2005). The Information Paper was couched in relatively high level terms, but stated that the ESC “would be unlikely to consider LRMC estimates based on the AIC approach to be adequate for the purpose of proposing prices in the next review” (ESC, 2005, p15). However, no common approach to estimating LRMC was adopted between water businesses subsequently.

England and Wales
In England and Wales, the regulator has considered using both approaches. OFWAT launched a review in 1997 investigating methods for using LRMC in water tariffs. Following the review, OFWAT required the water companies in England and Wales to submit LRMC estimates, including annual updates from 2001. The water companies were able to use either the Turvey or AIC approaches to calculate their LRMC estimates and most, but not all, opted for the AIC approach. OFWAT responded to the initial estimates the companies provided with scepticism, partly due to the wide range in LRMCs calculated by different companies and issued detailed guidance on how the approach should be implemented in 2002. Nonetheless, the LRMC estimates were not used to set the tariffs for end users, which in part may reflect the lack of metering for many household customers. Although never implemented in practice as the basis for widespread pricing reforms, the England and Wales case illustrates the sensitivities of the LRMC estimates to the approach used.
Conclusion

While achieving efficiency in the procurement, treatment, transport and consumption of water is almost universally considered to be a desirable outcome, regulators and water utilities do not always price water services in line with this objective, i.e., by reference to LRMC. Moreover, regulators and utilities have adopted inconsistent approaches for estimating the underlying LRMC.

Of the two commonly employed approaches to estimate LRMC for setting prices, the Turvey approach most closely approximates the marginal costs because the cost estimate represents the change in costs as a result of a specified change in demand. The AIC approach, on the other hand, uses the average costs of future increases in demand as an approximation for the costs of providing an additional unit of the service. Turvey’s conceptual superiority comes at a price: The process of calculating the Turvey approach is more resource and informationally intensive than the AIC approach. There can also be additional subjectivity associated with the Turvey approach due to the need to pick an increment to demand and forecast additional optimal expansion plans with and without that increment.

In practice, where regulators have attempted to introduce LRMC signals in prices, they have tended to use AIC to estimate LRMC in the water sector for reasons of computational simplicity. It may be that, as experience with using LRMC to define tariffs grows, more regulators will follow the ESC in Victoria and seek to move away from AIC to more marginal concepts, such as the Turvey approach.
In any case, where the marginal technology is increasingly expensive and/or where existing assets are largely depreciated, AIC will tend to be higher than average historic cost and closer to the marginal cost of providing water services. It follows that either the AIC or the Turvey approach is likely to provide better signals for efficient consumption than relying on average historic cost. Irrespective of the calculation method chosen in future regulatory decisions, rising water scarcity will continue to put pressure on tariff policy and encourage the use of more marginal cost concepts in prices. Industry observers should expect to see increasing use of marginal cost concepts and increasingly marginal cost concepts employed in setting end-user prices.

**Bibliography**


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